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Errata

Page 410, line 17 from bottom, for Pretz read Fretz.
Page 412, line 10, for Pretz read Fretz.
Page 418, lines 1 and 13 from bottom, for Pretz read Fretz.
Page 638, line 18, for *chryptandrus* read *cryptandrus*.

Vol. 42 No. 1

BULLETIN

OF THE

TORREY BOTANICAL CLUB

JANUARY, 1915

West Indian mosses—II. Mosses of the Danish West Indies and Virgin Islands

ELIZABETH GERTRUDE BRITTON

(WITH PLATE 1)

In February, 1913, Miss Delia W. Marble and I spent four weeks collecting on the island of St. Thomas, while Dr. Britton and Dr. Shafer cruised around among the other islands of the Archipelago in search of cacti and other plants. An account of their trip will be found in the Journal of the New York Botanical Garden.*

As far as we know, no record of any other collection of mosses from these islands exists, excepting the brief account given by Dr. I. Urban† of the collections made by the Rev. Johann Christian Breutel in 1841. Most of Breutel's mosses, 310 numbers, are deposited at the British Museum, but his collections included specimens from St. Thomas, St. Croix, St. Jan, St. Kitts, and Antigua, as well as the collections made in South Africa in 1853–1854. This would account for the large number of specimens preserved in his herbarium, as our experience has shown that the Danish and Virgin Islands are not particularly rich in species of bryophytes.

William Mitten had a few duplicates from Breutel's collections including the following six species: *Calymperes Richardi* C. Müll. (distributed as *C. Afzelii* Sw.), *Hymenostomum Breutelii* (C. Müll.) Broth., *Tortula agraria* (Sw.) Sw., *Philonotis tenella* (C.

* Jour. N. Y. Bot. Garden 14: 99. 1913.

† Symbolae Antill. 3: 28. 1902.

[The BULLETIN for December (41: 577–657. *pl. 21–23*) was issued Ja 8, 1915.

Müll.) Jaeg., *Stereophyllum leucostegum* (Brid.) Mitt. (distributed as *Hypnum Breutelii* Schimp.), and *Taxithelium planum* (Brid.) Mitt. (distributed as *Hypnum Antillarum* Schimp. ms.).

Baron von Eggers collected a few mosses in St. Thomas, St. Jan, and Tortola in 1887, but as far as we know no list of these has been published.

We collected about seventy packets, but found only twenty-eight species, representing twenty-two genera, though we added three new species, a small *Phascum*, a sterile *Hyophila*, and a sterile *Bryum*, which has since been found on Mona Island also.

A brief synonymy with localities and habitat of these species is given in the following enumeration: Nos. 1–4 and 7–9 were determined by Mr. R. S. Williams; Nos. 16 and 17 by M. G. Dismier. Unless otherwise noted the specimens cited were collected by Miss Marble and myself.

1. DICRANELLA LONGIROSTRIS (Schwaegr.) Mitt. Jour. Linn. Soc. Bot. **12**: 30. 1869

ST. JAN: without definite locality, *Breutel*, 1841.

2. LEUCOLOMA SERRULATUM Brid. Bryol. Univ. **2**: 752. 1827

Leucoloma Riedlei Besch. Jour. de Bot. **5**: 146. 1891.

ST. THOMAS: on trees in wet woods, *Riedlé*.

3. OCTOBLEPHARUM ALBIDUM (L.) Hedw. Descr. **3**: 15. 1791

ST. THOMAS: on roots of an *Anthurium*, stone walls, between Pearl and Bonne Resolution near Caret Bay, *1337*.

4. LEUCOBRYUM POLAKOWSKYI (C. Müll.) Cardot, Mém. Soc. Sci. Nat. Cherbourg **32**: 82. 1900

TORTOLA: on rotten wood, Sage Mt., *W. C. Fishlock 83*, May, 1913. Also in Porto Rico, *E. G. Britton 2518*, April, 1913.*

5. FISSIDENS KEGELIANUS C. Müll. Linnaea **21**: 181. 1848

ST. THOMAS and ST. JAN: at base of palms and on the ground, *Breutel*, 1841 (distributed as *F. palmatus* [Sw.] Hedw.). ST. JAN: wet bank, Bethania, *Britton & Shafer 208a*. ST. THOMAS:

* Both these are additions to ranges since the publication of Part 2, Vol. 15, of North American Flora.

moist banks near French wharf; Water Island, Cowell Point, *147;* St. Peter, *38, 98;* Magin's Bay, *191;* Smith's Bay, *1289, 1316, 1459.*

6. FISSIDENS ELEGANS Brid. Spec. Musc. 167. 1806

ST. JAN; on wet rock, Bethania, *Britton & Shafer 361.* ST. THOMAS: Cowell Point, *100.*

7. SYRRHOPODON FLAVESCENS C. Müll. Syn. 1: 541. 1849

ST. JAN: on rotten wood, Bordeaux, 300 m. alt., *Britton & Shafer 549.* TORTOLA: without definite locality, *W. C. Fishlock 82.* May, 1913.

8. CALYMPERES RICHARDI C. Müll. Syn. 1: 524. 1849

Calymperes Breutelii Besch. Ann. Sci. Nat. Bot. VIII. 1: 278. 1895.

Calymperes hexagonum Besch. l. c. 286.

Calymperes Hookeri Besch. l. c. 287.

ST. THOMAS: without definite locality, *Breutel* (type of *C. Breutelii*); without definite locality, *L. C. Richard* (type of *C. hexagonum*); on rocks, summit of ridge, by roadside, north of Charlotte Amalia, *408;* on bank, Cowell Point, *101.* TORTOLA: Roadtown to High Bush, 325 m. alt., *Britton & Shafer 772.*

9. CALYMPERES LONCHOPHYLLUM Schwaegr. Suppl. 1[2]: 133. *pl. 98.* 1816

TORTOLA: Sage Mt., *W. C. Fishlock 85a,* May, 1913.

10. HYMENOSTOMUM BREUTELII (C. Müll.) Broth.; E. & P. Nat. Pfl. 1[3]: 386. 1902

Weisia Breutelii C. Müll. Syn. 1: 664. 1849. Not Schimp.

Gymnostomum Breutelii Br. & Sch.; Paris, Index Bryol. 542. 1895.

Weisia senocarpa C. Müll. Syn. 2: 633. 1851.

Gymnostomum senocarpum Jaeger, Adumb. 1: 280. 1873.

Hymenostomum senocarpum Paris, Index Bryol. 597. 1895.

Weisia Pabstiana C. Müll. Bot. Zeit. 15: 382. 1857.

Weisia edentula Sull. Proc. Am. Acad. 5: 273. 1861. Not Mitt.

Hymenostomum cubense Hampe; Paris, Index Bryol. Suppl. 189. 1900.

ST. JAN: Emaus, *Breutel* (type locality); wet banks, Bethania, *Britton & Shafer 209;* Rosenberg and Bordeaux, *Britton & Shafer 288, 534, 569.* ST. THOMAS: on the ground, Water Island, *155;* roadside banks, summit of ridge, Bonne Resolution, *1336;* Bordeaux, *1384;* St. Peter, *1258;* top of Flag Hill, *Fitch & Shafer 1494.* TORTOLA: Peter Island, *Britton & Shafer 860.* ANAGADA: without definite locality, *Britton & Shafer 1039*

11. **Hyophila uliginosa** E. G. Britton sp. nov.

Plants attached to rocks in stream, gregarious and matted together by fresh water algae, soft and flaccid when moist; stems simple, about 5 mm. high, branching at apex; leaves much discolored and clogged with mud at base, green and spreading at summit of stems, about 1 mm. long; base hyaline and oblong; apex lingulate and slightly carinate, apiculate; margins plane, entire or rarely denticulate with a few hyaline teeth at apex; costa stout, papillose on back and smooth above ending in the cuspidate point, in section showing one row of ducts and two small bands of stereid cells; basal cells hyaline, oblong or square, up to 16 μ long by 8 μ wide, upper cells obscure up to 5 μ in diameter, green and densely papillose, with several minute papillae on each surface; dioicous; flowers and fruit unknown; propagating by septate gemmae borne in clusters on brown filaments in the axils of the leaves. [PLATE 1, FIG. 1–6.]

TYPE LOCALITY:—ST. JAN: Bethania, *Britton & Shafer 367.*

12. **Phascum sessile** E. G. Britton sp. nov.

Plants annual(?), gregarious in loose bare earth, on banks; stems simple, or branching at base, with several rosettes from one root, 1–2 mm. high; leaves inrolled with conspicuous yellowish-white costa when dry, bright green in color and spreading when moist, few, 8–12, oblong at base, obovate above, 1–1.25 mm. long by 0.4–0.5 mm. wide; costa percurrent or excurrent into a short cuspidate point, terete and smooth on back, with a narrow dorsal stereid band and 2–3 rows of large ducts; margins entire or finely crenulate and papillose; upper cells hexagonal, up to 13 μ in diameter, densely chlorophyllose with 1–3 papillae on each surface; lower cells hyaline, oblong, 10–12 rows, up to 40 μ long, not papillose, occasionally curved and yellow and slightly auriculate at basal angles; paroicous, antheridia few, with paraphyses, in small buds below or near the archegonia, of which occasionally several are fertilized making 2–3 fruits on one plant; calyptra small, conic, split, slightly papillose at apex; capsule immersed,

sessile on a small brown vaginule, globose, 0.5 mm. in diameter, sharply apiculate, indehiscent; walls with irregular hexagonal cells, 27–32 μ in diameter; spores brown, slightly roughened, 27–30 μ in diameter, maturing in spring. [PLATE 1, FIG. 7–13.]

TYPE LOCALITY:—ST. THOMAS: Cowell Point, *E. G. Britton 99*, February 2, 1913.

DISTRIBUTION:—ST. THOMAS: Water Island, *150, 156.*

This species belongs to the section *Microbryum* and is close to *P. Floerkeanum*, but differs in the less acuminate and less subulate leaves with plane margins without a yellow border, and more chlorophyllose and papillose cells.

13. TORTULA AGRARIA (Sw.) Sw. Fl. Ind. Occ. 3: 1763. 1806

ST. JAN: Bethania, *Breutel;* Bethania, *Britton & Shafer 241, 268.* ST. THOMAS: on limestone walls of old cemeteries, *Breutel;* on damp earth, Nisky, *77;* Cowell Point, *97;* old walls, Crown Estate, 450 m. alt., *1369;* on rocks at waterfall, Magen's Bay, *1315;* stone walls, Bonne Resolution School, *442.*

14. **Bryum micro-decurrens** E. G. Britton sp. nov.

Plants gregarious, in loose soil, brown at base and also more or less brown above, from the excurrent awns; stems dull green, slender, erect and mostly simple, unbranched, not more than 5 mm. high, matted with brown tomentum at base; leaves erect-appressed when dry, not twisted nor glossy; spreading when moist, less than 1 mm. long by 0.2 mm. wide; costa wide at base 40 μ (at least .2 width of leaf), excurrent into a short subulate brown awn, slightly toothed at apex and on awn; cells of blade hexagonal, 27–40 μ long $\times$ 10 μ wide, basal cells shorter, oblong, *with a long, decurrent narrow wing of one row of cells, extending down the stem to the next leaf;* margins bordered by one row of longer narrow cells 5 μ $\times$ 54 μ long, slightly revolute below and serrulate above; only known from sterile specimens.

TYPE LOCALITY:—ANAGADA: rocky plain near settlement, *Britton & Shafer 1038.*

DISTRIBUTION:—Mona Island, *Britton & Hess 1751, 1753.*

These specimens have been compared with type specimens of *B. decursivum* C. Müll. from Porto Rico, kindly loaned to us by Dr. Engler from the Royal Botanical Garden at Berlin, and, though closely related by the decurrent narrow basal wing, ours differs in its shorter leaves, serrate margins and shorter cells.

15. BRYUM CRUEGERI Hampe; C. Müll. Syn. 1: 300. 1849

Dioicous plants bright yellowish green, shining gregarious in loose soil in gravelly bed of stream; stems short, less than 1 cm. high, upper part of stem erect, base decumbent red and radiculose; leaves light yellowish green, glossy, spreading, lanceolate, acute or acuminate, 2 mm. long × 0.35–0.5 mm. broad; costa narrow, ending in the carinate, mucronate apex, margins entire below slightly serrulate at apex, not bordered nor revolute; cells hexagonal 54–108 μ long × 13 μ broad, a few alar, shorter and broader, square or oblong, not decurrent; sterile but often propagating by gemmae.

ST. THOMAS: in bed of stream at Tutu, *422*.

Compared with *Chas. Wright 63* from Cuba, distributed as *B. ovalifolium* Sull., the leaves are slightly narrower and less concave, but they are evidently closely related species and both belong with the group of tropical American species having glossy leaves, and flaccid red stems, resembling a *Pohlia*. They grow mostly along streams and form a closely related group, of which *B. ripense* C. Müll. from Jamaica is also a member.

16. PHILONOTIS SPHAEROCARPA (Sw.) Brid. Bryol. Univ. 2: 25. 1827

ST. THOMAS: moist banks, Bonne Resolution *421;* Crown Estate, 450 m. alt., *1368*, *1458*.

17. PHILONOTIS TENELLA (C. Müll.) Jaeger, Adumb. 1: 541. 1873–1874

ST. JAN: on wet banks, near Corallenburg, *Breutel*, 1841; Bethania, *Britton & Shafer 208*. TORTOLA: near Roadtown, 325 m. alt., *Britton & Shafer 773*.

18. PIREELLA CYMBIFOLIA (Sull.) Cardot, Rev. Bryol. 40: 17. 1913

ST. JAN: on wet rock near Bethania, *Britton & Shafer 359*.

19. PTEROBRYUM ANGUSTIFOLIUM (C. Müll.) Mitt. Jour. Linn. Soc. Bot. 12: 426. 1869

TORTOLA: High Bush, *Eggers 3240a*, December, 1887; Sage Mt., *W. C. Fishlock 85*, May, 1913.

20. NECKERA DISTICHA (Sw.) Hedw. Descr. 3: 53. 1792

ST. THOMAS: on rocks at St. Peter, *1456*. TORTOLA: on rock in forest, High Bush, 375 meters alt., *Britton & Shafer 841*.

21. NECKERA JAMAICENSE (Gmel.) E. G. Britton, Bull. Torrey Club 40: 656. 1913

ST. JAN: on bark of trees at Bethania, *Britton & Shafer 364*.

22. CALLICOSTELLA BELANGERIANA (Besch.) Jaeger, Adumb. 2: 257. 1874–1875

ST. JAN: on stones, Bordeaux, 300 meters alt., *Britton & Shafer 548*.

23. STEREOPHYLLUM LEUCOSTEGUM (Brid.) Mitt. Jour. Linn. Soc. Bot. 12: 543. 1869

ST. JAN: Emaus, *Breutel;* Bethania, *Britton & Shafer 1357*. ST. THOMAS: on rocks in shade, ravine at Tutu, *1291*; waterfall near Magen's Bay, *1314*.

24. MITTENOTHAMNIUM DIMINUTIVUM (Hampe) E. G. Britton, Bryologist 17: 9. 1914

ST. JAN: on dead wood, Bordeaux, 400 m. alt., *Britton & Shafer 595*.

25. TAXITHELIUM PLANUM (Brid.) Mitt. Jour. Linn. Soc. Bot. 12: 496. 1869

ST. JAN: *Breutel;* Bethania, *Britton & Shafer 358, 365, 366;* Bordeaux, 400 m. alt., *Britton & Shafer 568, 580*. ST. THOMAS: St. Peter, *1259;* Crown Estate, *1366*. TORTOLA: High Bush, *Britton & Shafer 839*.

26. SEMATOPHYLLUM ADMISTUM (Sull.) Mitt. Jour. Linn. Soc. Bot. 12: 485. 1869

ST. JAN: Bordeaux, 300 m. alt., *Britton & Shafer 554, 556, 578, 579*. ST. THOMAS: St. Peter, on rocks, *1257, 1457*. TORTOLA: High Bush, 375 m. alt., *Britton & Shafer 814, 840*.

27. SEMATOPHYLLUM SERICIFOLIUM Mitt. Jour. Linn. Soc. Bot. 12: 483. 1869.

TORTOLA: on logs in forest, High Bush, 375 m. alt., *Britton & Shafer 819*

28. HAPLOCLADIUM MICROPHYLLUM (Sw.) Broth.; E. & P. Nat. Pfl. I³: 1007. 1907

ST. THOMAS: shaded bank, Pearl to Bonne Resolution, *1335*.

Explanation of plate 1

The figures were drawn by Mr. R. S. Williams from magnifications twice as great as expressed in the numbers, which represent the magnification of the figures as they stand in the reproduction.

HYOPHILA ULIGINOSA E. G. Britton

FIG. 1. Plant, natural size.
FIG. 2. Propagula, × 35.
FIG. 3. Upper leaf, × 35.
FIG. 4. Cells in upper part of leaf, × 200.
FIG. 5. Cells of leaf base, × 200.
FIG. 6. Cross section in upper part of leaf, × 200.

PHASCUM SESSILE E. G. Britton

FIG. 7. Plant, × 11.
FIG. 8. Cross-section in upper part of leaf, × 200.
FIG. 9. Cross-section near leaf base, × 200.
FIG. 10. Calyptra, × 35.
FIG. 11. Cells at basal angle, × 200.
FIG. 12. Cells in upper part of leaf, × 200.
FIG. 13. Upper leaf, × 20.

A new American fossil moss

ELIZABETH G. BRITTON AND ARTHUR HOLLICK

(WITH TWO TEXT FIGURES)

Some seven years ago it was our privilege to describe the first known specimen of an American fossil moss in fruit, under the name *Glyphomitrium Cockerelleae*,* found at Florissant, Colorado.

FIGS. 1, 2. *Plagiopodopsis Scudderi* E. G. Britton & A. Hollick. FIG. 1. Photograph of specimen, natural size. FIG. 2*a*. A single plant enlarged about five times, showing capsule and leaves. FIG. 2*b*. Part of another plant, similarly enlarged. FIG. 2*c*. A sterile plant, similarly enlarged.

Recently we received from Dr. F. H. Knowlton, of the United States National Museum, another similar specimen from the same locality, which represents, however, a different and, apparently, an undescribed genus.

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* Elizabeth G. Britton and Arthur Hollick, Bull. Torrey Club **34**: 140, *pl. 9, f. 6, 6a.* 1907.

Plagiopodopsis Scudderi gen. et sp. nov.

Plants cespitose, matted together by basal radicles: stem about 1 cm. high, erect, simple or branching; leaves crowded, spreading, about 2 mm. long by 0.5 mm. wide, lanceolate-acuminate, costate to apex; perichaetial leaves longer extending to or beyond the capsule; seta terminal, 2–3 mm. long, erect and partly exserted; capsule ovoid, 1.5 mm. long by 0.75 mm. broad, erect or inclined, rugose or plicate; mouth 0.5 mm. broad, too indistinct to show any traces of peristome; calyptra and lid unknown.

Named in honor of Mr. Samuel H. Scudder, by whom it was collected about the year 1875, in the Tertiary (Miocene) shales of Florissant, Colorado. Type specimen in U. S. National Museum.

It resembles the living species *Plagiopus Oederi* (Gunn.) Limpr. of the Bartramiaceae in size, habit, etc., but is too poorly defined for anything more than identification of its close relationship to the genus *Plagiopus*, as indicated in the generic name adopted for it.

Phytogeographical notes on the Rocky Mountain region
IV. Forests of the Subalpine and Montane Zones*

P. A. Rydberg

The mountain regions may be divided into four zones: (1) the Alpine Zone, above the timberline; (2) the Subalpine Zone; (3) the Montane Zone; (4) the Foothill Zone. These correspond to Dr. Merriam's Arctic, Hudsonian, Canadian, and Transition life-zones, respectively. The Alpine Zone has already been discussed by me in three preceding papers. The Subalpine and Montane Zones are more or less mesophytic, while the Foothills are decidedly xerophytic. The characteristic trees of the last are the bull pines and nut-pines and the cedars, which there seldom form dense woods, but grow more or less scattered on the hillsides. The Subalpine and Montane Zones are characterized (with the exception of the exposed ridges and larger open valleys or "parks") by more or less dense woods of spruce, fir, pines and aspen. Many do not distinguish these two zones, and no definite line can be drawn between them. Most of the plants are common to both; the most characteristic tree of the Subalpine Zone, the Engelmann spruce, extends far down into the Montane Zone, and several of the principal components of the latter, especially the Douglas spruce, extend far up into the former. In general the division line may be placed at the upper limit of growth of the bull-pine and the lower of the subalpine fir. This varies considerably. In Colorado it may be placed at an altitude of 3,000 m. (10,000 ft.), in the Yellowstone National Park at 2,300–2,500 m. (7,500–8,000 ft.), in the Glazier Park Region of Montana at

* This article is not intended to present any new facts, but merely a summary. The only feature as far as I know that has never been presented in print in this form is the division line drawn between the Northern and Southern Rockies and the reasons for drawing it at that particular place. The distribution of the forest trees both altitudinally and geographically has been treated more extensively and in greater detail elsewhere, both in the various "tree books" and in the reports from the United States Forest Reserves, but a short resumé is always desirable.

about 2,000 m. (6,500 ft.), and in the Selkirk Mountains of British Columbia still lower.

A region which extends twenty degrees in latitude* will naturally not be homogeneous, as far as its vegetation is concerned. It also can be divided into two principal parts: the Northern and the Southern Rockies. In Wyoming, about where the Union Pacific Railroad is drawn across, there is a break in the high mountain chain. This break may be regarded as the division line between the Northern and the Southern Rockies.

The larger part of the Southern Rockies is within the state of Colorado, but they extend south into New Mexico to Santa Fe, and northward into Wyoming, where they are known as the Medicine Bow Mountains. West of the Southern Rockies and separated from them by the Green River basin are the Uintah and Wasatch Mountains. The former have practically the same flora as the Southern Rockies, but the western slope and southern end of the Wasatch Range partake of the floral nature of the isolated mountain chains of the Great Basin. The northern end of the Wasatch Mountains, the range enclosed by the horseshoe bend of the Bear River in southern Idaho, is the most northerly extension of the floral district of the Southern Rockies. It is here and across the Bear River in the Teton Mountains, not along the continental divide in Wyoming, that the floras of the Northern and Southern Rockies meet.

The Northern Rockies form an uninterrupted chain from Yukon Territory to the Wind River Mountains in Wyoming and the flora is practically homogeneous, except the western slope of the northern portion. To the Northern Rockies should also be counted several more or less isolated mountain ranges, as the Saw-tooth Mountains of central Idaho, the Tetons of western Wyoming, the Cypress Hills in Saskatchewan, several ranges in Montana, the Bighorn Mountains in northern Wyoming and the Black Hills and several smaller chains in their neighborhood. None of these except the Big Horns and the Tetons can be taken in account when the subalpine flora is considered. The Selkirk Mountains between the bends of the Upper Columbia River,

* My discussion in this paper refers only to the region between 35° and 55° latitude.

much closer to the Rockies, and separated from the Cascades by the Columbia and Frazer River valleys, have a flora resembling that of the Cascades as much as that of the Rockies. This Cascade flora, however, extends also to the western slopes of the Rockies in British Columbia and northern Montana as well as into the Bitter Root Mountains between that state and Idaho, although the Bitter Roots are separated from the Selkirks by the valleys of Kootenay River and Clark's Fork.

This division between Northern and Southern Rockies is not made merely on geographical grounds, i. e., because there is a break in the high mountain chain where the plains actually cross over the continental divide. The flora shows also many differences; this is especially the case with the more characteristic species, the trees. It is true that a number of these are common to the Northern and Southern Rockies, as, for instance, *Picea Engelmannii*, *Pinus scopulorum*, *Pinus Murrayana*, *Pinus flexilis*, *Pseudotsuga mucronata*, *Abies lasiocarpa*, *Sabina scopulorum*, *Betula fontinalis*, *Alnus tenuifolia*, and several species of *Crataegus*, *Salix*, and *Populus;* but others are not.

Pinus aristata, *P. edulis*, *Picea Parryana*, *Abies concolor*, *Sabina utahensis*, *S. monosperma*, *Populus Wislizeni*, *P. Fremontii*, *Fraxinus anomala*, and the oaks of the *Quercus Gambellii* and *Q. undulata* groups are characteristic of the Southern Rockies. Of these only *Picea Parryana* has been collected in what belongs to the Northern Rockies. The only authentic locality there that I know is in the Teton Mountains, and these are, as stated before, in the region where the two floras meet. *Abies concolor* extends into the Bear River Mountains but does not cross the line, although it is found much farther north in western Oregon. It has been reported from other parts of Idaho, but evidently has been confused with *A. grandis*, at least all specimens I have seen named *A. concolor* belong to that species. *Sabina utahensis* is found on the southwestern slopes of Wind River Mountains in the Green River basin, but this species belongs to the foothills and not to the mountains proper. The only oak found in the Northern Rocky Mountain region is *Quercus macrocarpa*, and this only in the Black Hills. It is not found in the Southern Rockies and it is an invader from the prairie region. The same can be said

about *Ulmus americana* and *Ostrya virginiana*. There are still more trees of the Northern Rockies which are not found in the southern part, such as *Larix occidentalis*, *L. Lyallii*, *Abies grandis*, *Tsuga heterophylla*, *T. Mertensiana*, *Picea albertiana*, *Pinus monticola*, *P. albicaulis*, *Thuja plicata*, *Taxus brevifolia*, several species of *Betula* and *Salix*, *Populus trichocarpa*, *P. hastata*, and *P. Besseyana*. It is true that most of the conifers mentioned belong principally to the Selkirk-Bitter Root region, but this is not the case with *Picea albertiana* and *Pinus albicaulis*, which extend as far south as the Yellowstone Park. *Abies grandis* has also been reported from there, and *Pinus monticola* a little north thereof.

SUBALPINE ZONE OF THE SOUTHERN ROCKIES

The characteristic trees of the Subalpine Zone of the Southern Rockies are *Picea Engelmannii* and *Populus tremuloides*, with *Pinus aristata* and *Abies lasiocarpa* as secondary ones.

The ENGELMANN SPRUCE, or, as it is usually called in the Rockies, the white spruce, has its best development in Colorado at an altitude between 10,000 and 11,500 feet. It extends up to the timberline, 11,500–11,800 feet or rarely up to 12,000 feet. This region from about 10,000 feet to the timberline may therefore be regarded as the Subalpine Zone. The spruce grows often in pure stands, as in the La Sal Mountains, or mixed with the subalpine fir, *Abies lasiocarpa*, and the forests usually cover the northern slopes, except where the conditions are such that no trees can grow. In favorable localities it also grows on the southern slopes, there occasionally mixed with *Pinus aristata*. It is not confined, however, to the Subalpine Zone, but extends far down on the northern slopes into the Montane Zone as low as to 7,000 or 6,500 feet altitude. Here, as well as in the lower portion of the Subalpine Zone, it is often mixed with the Douglas or red fir, *Pseudotsuga mucronata*, the blue spruce, *Picea Parryana*, the balsam fir, *Abies concolor*, the limber pine, *Pinus flexilis*, and the lodge-pole pine, *Pinus Murrayana*. *Picea Engelmannii* extends throughout the northern Rocky Mountain region, but is not there so exclusively the tree characteristic of the Subalpine Zone.

The Engelmann spruce is a slender tree with narrow crown,

therefore offering little resistance to the wind. The branches are short, slender and deflexed, therefore well adapted for shedding the falling snow. It is, hence, very well adapted to the severe climate of the mountain peaks. At the timberline it, as well as *Abies lasiocarpa*, becomes stunted, low, with the lower branches enormously elongated and closely pressed to the ground. The Engelmann spruce is a slow grower, naturally so on account of the poor and rocky soil and the severe climate. On a stump from a tree cut in the La Sal Mountains, measuring 26 inches, I counted over 260 annual rings. In very favorable conditions it may reach a height of 120 feet and a diameter of about 3 feet.

Next to the Engelmann spruce, the ASPEN is the most common tree in the Subalpine region of Colorado. It grows on both slopes, usually in groves, but sometimes mixed, and usually prefers rich soil. After the spruce wood has been destroyed by forest fires, it often takes possession of the ground, as its seeds germinate more quickly and it is a faster grower. It reaches its best development along streams and in springy places. It is seldom found up to an altitude of more than 11,000 feet and its height is seldom over 25 or 30 feet in this region.

The FOX-TAIL PINE, range pine, or prickle-cone pine, *Pinus aristata*, is the chief tree of the southern slopes of the Southern Rockies. It is not found in the Northern Rockies at all, but exists in the mountains of the Great Basin and in the southern Sierra Nevada. It is a bulky tree, branched usually near the base. In favorable situations it sometimes reaches a height of 50 feet, with a trunk 3 feet in diameter. Near the timberline it becomes very gnarled, crooked, and twisted, with the branches short and few on the windward side and unproportionally developed on the leeward one. It never forms the depressed cushion-like or sugar-loaf-like growth of *Picea Engelmannii* or *Abies lasiocarpa* in similar situations. *Pinus aristata* is a characteristic tree of the Sulbapine Zone, only rarely found in the Montane Zone as low as 8,000 feet. If found there it grows mostly with *Pinus flexilis*, as it does sometimes in the Subalpine Zone.

The fourth of the trees of the Subalpine Zone is the SUBALPINE FIR, *Abies lasiocarpa*. It usually grows scattered among *Picea*

Engelmannii or at lower altitudes sometimes with *Pinus Murrayana*. It is usually a small tree, very rarely reaching 70 or 80 feet in height, with a trunk of 2 feet in diameter, the average good-sized tree being 45 or 50 feet high. It is found at an altitude of from about 9,000 feet to the timberline.

The limber pine, *Pinus flexilis*, belongs really to the Montane Zone, where it has its best development, but extends into the Subalpine Zone almost to the timberline.

SUBALPINE ZONE OF THE NORTHERN ROCKIES

As the Northern Rockies are of much larger extent than the Southern and the conditions are much more variable, the description of the different zones of one locality will poorly fit for all places. I shall therefore first select a fairly typical region near the center of the district and then contrast with this the outlying regions. The region selected is the main range of the Rockies in northern Montana. The Subalpine Zone in this region extends from an altitude of about 6,500 feet to the timberline. The most important tree is, as in the Southern Rockies, the Engelmann spruce (*Picea Engelmannii*), but it becomes less predominant, and the subalpine fir, *Abies lasiocarpa*, becomes more frequent. Both are characteristic of the northern exposures.

The ENGELMANN SPRUCE, just as in the Southern Rockies, is not limited to the Alpine Zone, but runs down through the Montane Zone to a little below 5,000 feet, and is there confined mostly to the northern slopes and valleys. In this region it sometimes reaches a height of 125 feet, with a trunk 3 feet in diameter. In some places especially on the west side of the Bitter Root Mountains, it is more or less supplanted by the next.

The SUBALPINE FIR, *Abies lasiocarpa*, grows between an altitude of 6,000 feet and timberline, rarely lower down. Under favorable conditions it reaches a height of 75 feet, with a trunk diameter of 2 feet.

The WHITE-BARKED PINE, or, as it is called in Montana, the nut pine, *Pinus albicaulis*, takes the place of *P. aristata* on the southern exposures, often growing scattered in grassy "parks." It resembles the same somewhat in growth, although it is more closely related to *P. flexilis*. It is a tree 20 to 40 feet high, with a trunk

1 to 4 feet thick. At the timberline it becomes low, crooked, and gnarled.

The LYALL'S LARCH, *Larix Lyallii*, is the most hardy tree of the region. In moist valleys it reaches higher up than either the spruce or the fir, and is more strictly a subalpine species than either, growing mostly above 7,500 feet altitude. In the main Rockies, it is not found south of latitude 48° 45′, but runs further south in the Bitter Root Mountains. It is mainly confined to the western slope of the Rockies, and crosses the main divide only north of Culver Glazier, latitude 48° 50′. It is a tree of slow growth, becoming 25 to 40 feet high and having a diameter of 2 to 4 feet.

The ASPEN plays here the same rôle as in the Southern Rockies, but is perhaps not so common.

In the lower portion of the Subalpine Zone, the lodge-pole pine, limber pine and Douglas fir are found on the drier slopes. In some places the former tree is the most common of all. The limber pine is rare on the west side of the divide.

In the Bitter Root Mountains the dividing line between the Subalpine and Montane Zones is slightly lower. The principal trees here are the same as in the main Rockies. The general distribution of the subalpine fir is above 4,800 feet in the northern part and 5,500 feet in the southern part, although it sometimes descends as low as 3,000 feet. Here it is much more common than *Picea Engelmannii* and is the characteristic tree of the Subalpine Zone. The latter grows mostly at 4,000 to 7,000 feet altitude. Lyall's larch is found along the main range of the Bitter Root Mountains to the headwaters of the south fork of the Clearwater River, latitude 45° 50′. *Pinus albicaulis* grows mostly above 6,000 feet altitude. *Pinus Murrayana* ascends to 8,000 feet and *Pseudotsuga mucronata* to 6,500 or 7,000 feet. *Pinus flexilis* is wanting. The first of these three species, i. e., *P. Murrayana*, is the most common tree on the eastern slopes of the Bitter Root Mountains and there makes up about ninety per cent. of the forest.

To the other subalpine trees are here added the ALPINE HEMLOCK, *Hesperopeuce Mertensiana*. It grows at an altitude of from 5,500 to 8,000 or even 9,000 feet. It is a tree of 60 to 100 feet in

height and 3 to 6 feet in diameter with a greatly developed crown. It is not found in the main Rockies, at least not within the United States. It is not uncommon in the Selkirks and extends south in the Bitter Roots as far as to the divide between the north and middle forks of Clearwater River.

In the Yellowstone Park and in the Tetons, the Subalpine Zone begins at an altitude of 7,500 or 8,000 feet and the timberline is at an altitude of about 10,000 feet. The trees are the same as those of northern Montana, except that the Lyall larch is lacking and the lodge pole pine is more common near the lower border.

In the Big Horn Mountains both the Engelmann spruce and the subalpine fir are scarce and in most cases the upper limit of the lodge pole pine constitutes the timberline.

In the Black Hills a Subalpine Zone can scarcely be spoken of, as the highest mountains are less than 7,500 feet. The subalpine species of the Rockies are wholly lacking.

MONTANE ZONE OF THE SOUTHERN ROCKIES

The upper and lower limits of the Montane Zone in Colorado are approximately at an altitude of 10,000 and 7,500 to 8,000 feet. The former is about the upper limit of *Pinus scopulorum*, the latter near the lower limit of *Pinus Murrayana*, and *Pseudotsuga mucronata* is rare below this altitude in Colorado. These three trees together with *Picea Engelmannii* are the most important timber trees of this zone.

The southern slopes of the mountains and the tops of the table lands are more or less xerophytic, and here the bull pine or yellow pine, *Pinus scopulorum*, and the Douglas or red fir, *Pseudotsuga mucronata*, are predominant. The northern slopes and more protected valleys and flats are decidedly mesophytic. The predominant tree on the northern slopes and in the valleys is the Engelmann spruce. The lodge-pole pine, *Pinus Murrayana*, is often found with the Engelmann spruce, but is often found on the upper plateaus in pure stands or mixed with the more xerophytic species.

The composition of the more *xerophytic forest* of the southern slopes is as follows:

The most important tree is perhaps the BULL PINE, *P. scopulo-*

rum, or, as it perhaps is more often known, *P. ponderosa scopulorum*. It is seldom found in Colorado above an altitude of 10,000 feet, which the writer regards as approximately the upper limit of the Montane Zone. It descends, however, far below the lower limit of this zone, even below an altitude of 5,000 feet; it is really in fact the only important tree of the foothills. It is a tree of wide distribution found nearly everywhere in the Montane and Foothill Zones of the whole Rocky Mountain region, as treated in this article. The only mountains I know of where it is lacking are the La Sal Mountains in eastern Utah, where the Douglas fir is also missing. The bull pine is a massive tree, sometimes becoming 110 to 125 feet in height and with a trunk almost 4 feet in diameter. A tree 3 feet in diameter is about 250 years old.

The DOUGLAS FIR, red fir, or red spruce, *Pseudotsuga mucronata*, is almost as important as the bull pine. It usually grows with the latter and reaches about the same size. It is common at an altitude of between 7,000 and 10,000 feet, but ascends sometimes as high up as 10,500 and very rarely up to nearly 11,000 feet, and descends seldom in the ravines as low as 6,000 feet. In the higher altitudes it mixes with *Pinus flexilis* and *P. aristata*, rarely with *Picea Engelmannii*, in the lower extremes it grows with the latter and *Abies concolor*. As to its geographical distribution, the Douglas fir has about as wide a distribution as any Rocky Mountain coniferous tree, the other widely distributed ones being *Picea Engelmannii* and *Pinus Murrayana*, and is surpassed among the trees only by the aspen. It ranges from Alberta and British Columbia to western Texas, northern Mexico and southern California.

The LODGE-POLE PINE comes next in importance. This is the most common conifer in the Montane Zone of the Northern Rockies, but is not so common nor so important in the Southern. It often grows in pure stands on gentle slopes or flats, but mixes also with other pines as well as with the Engelmann spruce. As the lodge-pole pine germinates more readily than the other conifers, it often takes possession of burnt-over areas, just as the aspen does. The young trees usually spring up close together and form almost impenetrable thickets. Standing so close together the trees grow very slowly in size and large trees are rare.

In open places they rarely reach a height of 50 feet and a trunk diameter of 2 feet or a little more. In Colorado the species grows at an altitude of 8,000 to 10,500 feet, sometimes descending below 8,000 feet and rarely reaching an altitude of 11,000 feet. Its range extends farther north than that of the *Pseudotsuga*, viz., up to Alaska, but not so far south.

The LIMBER PINE or white pine of Colorado, *Pinus flexilis*, is rather local, never plentiful, and as a rule mixed with other trees, mostly with *Pinus scopulorum* and *Pseudotsuga mucronata* at lower altitudes and with *Pinus aristata* at higher ones. It ranges from an altitude of 7,500 feet nearly up to timberline. It is therefore a tree common to the Subalpine and the Montane Zones. In general appearance it is intermediate between the foxtail pine and the bull pine and is often mistaken for either. It ranges from Alberta to western Texas and southern California.

The red cedar, *Sabina scopulorum*, belongs rather to the Foothill Zone, but ascends often to an altitude of 9,000 feet and grows associated with the bull pine.

The composition of the *mesophytic forest* of the northern slopes consists of the following trees:

The principal tree here, as in the Subalpine Zone, is the ENGELMANN SPRUCE, which has been discussed already.

The subalpine fir is found mostly in the transition region between 9,500 and 10,000 feet, rarely as low as 9,000 feet altitude.

The BALSAM FIR or Colorado white fir, *Abies concolor*, takes its place at lower altitudes, viz., between 8,000 and 9,000 feet. It is a tall symmetrical tree with short horizontal branches, sometimes reaching a height of 250 feet. Its geographical distribution extends over the Southern Rockies, Sierra Nevada and other mountains of California, north to the Siskiyou Mountains of Oregon, but it is not found in the Northern Rockies.

The Douglas fir and the lodge-pole pine are also mixed occasionally with the Engelmann spruce.

Along the water-courses the composition of the forest is as follows:

The COLORADO BLUE SPRUCE, *Picea Parryana*, is growing along the water courses in the region mostly occupied by the bull pine and Douglas fir. It is therefore often found on the southern

slopes. It needs a good deal of moisture, but at the same time prefers an open forest, and stands less shade than the Engelmann spruce. This explains perhaps why it succeeds better as a planted tree in the Eastern States than any other western species. It ranges in altitudes from 6,500–9,000 feet or sometimes 10,000 feet, but descends into the foothills only in the valleys. It grows to the height of 90 feet and a trunk diameter of 2½ feet, or becomes rarely 100 feet high and 4 feet thick. It is limited to the Southern Rockies, and has been collected, as far as I know, only at one locality in what I regard as belonging to the Northern Rockies, viz., the Teton Mountains of western Wyoming.

The NARROW-LEAVED COTTONWOOD, *Populus angustifolia*, grows along the streams throughout the foothills as well as the Montane Zone, in other words at an altitude between 5,000 to 10,000 feet, or rarely as high as 10,500 feet. It becomes sometimes 50 feet high with a trunk nearly 2 feet in diameter, but this size is extremely rare. Individuals with somewhat broader leaves are sometimes mistaken for the balsam poplar, *P. balsamifera*. *Populus angustifolia* is distributed from North Dakota and Washington to New Mexico and California. The BALSAM POPLAR, *Populus balsamifera*, is rare in Colorado and belongs to the northern Rockies. It has about the same altitudinal distribution as the preceding and attains the same size or a little larger.

The WESTERN BLACK BIRCH, *Betula fontinalis*, and the ROCKY MOUNTAIN ALDER, *Alnus tenuifolia*, grow in similar situations, but never become trees of any large size. They are found throughout the Rocky Mountain region, in Colorado growing at an altitude between 5,500 and 9,000 feet, the latter sometimes reaching 10,000 feet.

Several species of willows are also found but most of these are mere shrubs.

The hawthorns (several species of *Crataegus*) and choke-cherry, *Prunus melanocarpa*, enter the lower valleys but belong really to the foothills or Great Plains.

MONTANE ZONE OF THE NORTHERN ROCKIES

The Montane Zone of the Rockies in northern Montana contains more species than in Colorado, especially on the western

side of the continental divide. On the eastern side the species are somewhat the same, but the proportion is different.

Eastern slope

The most common tree is the lodge-pole pine, growing on the dryer ridges from 5,000 to 8,000 feet altitude. It grows often in pure stands or mixed with Douglas fir and limber pine.

The Rocky Mountain bull pine, *Pinus scopulorum*, if found at all, is limited to the foothills or the mountain sides bordering thereon.

In the valleys with northeastern or northern exposure, the Engelmann spruce often is mixed with red fir and the ALBERTA SPRUCE, *Picea albertiana*. The latter is not generally distinguished from *Picea Engelmannii* or else mistaken for the eastern white spruce, *Picea canadensis*, which is not found in Montana, and further south for the blue spruce, *P. Parryana*. It much resembles the Engelmann spruce, but the twigs are glabrous and the cone-scales more rounded. The Engelmann spruce runs down as low as 6,000 feet altitude.

The deciduous trees are found mostly along the water courses. The most important are *Populus balsamifera* and *P. angustifolia*, *Betula papyrifera* and *Betula fontinalis*, *Alnus tenuifolia* and a few willows.

Western slope

The southern exposure is, as in the Southern Rockies, more xerophytic and this is mostly occupied by the lodge pole pine and the Douglas fir, ranging at an altitude between 3,000 or 4,000 to 7,000 or 8,000 feet. Below 4,000 feet the forest consists mostly of the WESTERN YELLOW PINE, *Pinus ponderosa*. This is closely related to *P. scopulorum* but has longer leaves and cones. Many regard the latter as a variety of the former. *P. ponderosa* is practically limited to the Pacific slope and has been reported from very few localities east of the divide. Contrary to its southeastern relative, it is found on rich soil. It belongs to the Arid Transition Zone of Washington and enters the Montane Zone only at its upper limit. It is a tree often over 200 feet high and with a trunk 5–8 feet in diameter.

On the northern exposures and in the canyons, the Engelmann

spruce and the Subalpine fir in the upper part are common; but at an altitude of 5,000 or 6,000 feet, are met with the western tamarack or larch, silver fir, western hemlock, white cedar and western white pine.

The WESTERN TAMARACK, or LARCH, *Larix occidentalis*, grows at an altitude of from 3,000 to 6,000 feet or rarely 7,000 feet, and always close to the water courses. It is a tree 60–150 feet high and 2–4 feet in diameter. Further west it sometimes attains a height of 250 feet and 6–8 feet in diameter. It ranges from British Columbia to western Montana and Oregon, east of the Cascades. No station east of the divide has been recorded, as far as the writer knows.

The SILVER FIR, *Abies grandis*, grows up to an altitude of 6,000 feet, rarely 7,000 feet. Near the Pacific coast it attains a height of 250–300 feet and a diameter of 4 feet, but in the mountains it seldom becomes more than 100 feet high and 2 feet thick. Its distribution is from Vancouver Island to western Montana, Idaho and northern California. It hardly crosses the Continental Divide in northern Montana, but has been reported from the Yellowstone National Park.

The WESTERN HEMLOCK, *Tsuga heterophylla*, grows up to an altitude of 6,000 feet. On the coast it becomes a tree 200 feet high. It is distributed from British Columbia and western Montana to central California. It, as well as the next, barely crosses the Continental Divide north of St. Mary's Lake.

The WHITE CEDAR, or western arbor-vitae, *Thuya plicata*, grows also up to about 6,000 feet. It is a tree sometimes 200 feet high and with buttresses 15 feet in diameter, but in Montana it is much smaller. Its distribution extends from Alaska to western Montana and northern California.

The MOUNTAIN WHITE PINE, *Pinus monticola*, extends to about the same altitude in Montana, but much higher in California. It is generally a tree 100 feet high and 4–5 feet in diameter, rarely larger. It grows mostly on bottom-lands and along streams. Its distribution is from British Columbia and northwestern Montana to Kern County, California. It is not found east of the divide in northern Montana, but has been reported in southern Montana from the valleys of Davis and Slough Creeks north of the Yellowstone National Park.

The deciduous trees belonging to this zone grow all along the water courses. They are: the cottonwoods, *Populus trichocarpa*, the tallest deciduous trees of America, *P. hastata*, *P. Besseyana*, *P. balsamifera*, *P. angustifolia* (rare on the west side), and *P. tremuloides* (the three first are seldom found east of the divide); further, such willows as *Salix Lyallii*, *S. sessilifolia*, *S. Mackenzieana*, *S. Scouleriana*, and several others, scarcely becoming trees; the birches, *Betula papyrifera*, *B. fontinalis*, *B. Piperi*, *B. subcordata*, and *B. occidentalis;* alders, *Alnus tenuifolia;* several species of *Crataegus* and *Amelanchier*, etc.

The Montane Zone in the Canadian Rockies is practically the same, but both its upper and lower limits are found gradually lower and lower down the mountains the further north one goes.

In the Bitter Root Mountains, it resembles much that of the western slope of the Rockies. To the conifers are added the PACIFIC YEW, *Taxus brevifolia*, which often becomes only an insignificant shrub. The extent of the Zone is between 4,000 and 5,800 feet altitude and the most important trees here on the northern exposures are the mountain white pine, *Pinus monticola*, which, however, extends in the valleys as far down as 2,000 feet altitude, and *Larix occidentalis*. On the southern exposures, *P. ponderosa* and *Pseudotsuga mucronata* are predominant.

In the Yellowstone National Park and mountains north thereof, about half of the coniferous flora consists of the lodge-pole pine. Otherwise the conditions are the same as on the eastern slope in northern Montana, that is with a small amount of *Picea Engelmannii* and *P. albertiana* on the northern exposures; *Pinus flexilis* and *P. ponderosa* on the southern exposures, but the latter two only near the lower limit; some *Pseudotsuga* on both, and aspen and cottonwood along the water courses. On the level plateaus of the Yellowstone National Park the forest consists of pure stand of *Pinus Murrayana*. A small number of *Pinus monticola* has been found on Davis Creek and Slough Creek in southern Montana and *Abies grandis* has been reported from Yellowstone Park.

In the Big Horn Mountains the coniferous forest is represented by but four species: *Pinus Murrayana*, *P. flexilis*, *Picea Engelmannii* and *Pseudotsuga mucronata*, of which the first makes up perhaps ninety per cent. of all.

The forest in the Black Hills consists mostly of bull pine, *Pinus scopulorum*. On the northern exposure of Harney Peak and the northern end of the limestone district above an altitude of 4,500 feet, there is some spruce, but it is not *Picea Engelmannii* but a form of the white spruce, *Picea canadensis*, with unusually short cones. This attains a height of about 100 feet and a diameter of nearly three feet. *Betula papyrifera*, *B. fontinalis*, *Populus angustifolia* and *P. tremuloides* are present. In the Foothill Zone are added *Quercus macrocarpa*, *Negundo interius*, *Populus Sargentii*, *P. acuminata*, *Ulmus americana*, *Ostrya virginiana*, and *Sabina scopulorum*. From this can be seen that the Black Hills do not represent a typical part of the Northern Rockies, as their forest flora contains fully as many species belonging to the eastern United States.

NEW YORK BOTANICAL GARDEN

The ferns and flowering plants of Nantucket—XIV

Eugene P. Bicknell

PRIMULACEAE

Samolus floribundus HBK.

In damp places either in fresh or in brackish soils. Common on marshy levels about ponds on the south shore; near Abram's Point; Shawkemo meadow; Pocomo. At the south shore it was in full flower June 8, 1908; near the north shore seedling plants only were found June 8, 1911, and first flowers not until July 1, 1912; continues in bloom through September.

Lysimachia vulgaris L.

An abundant growth along a weedy lot on Sea Street, first seen in 1899, continued to flourish there for many years until, in 1912, it was nearly exterminated by improvement of the grounds. Collected in full flower August 18, 1878, by Edwin Faxon. Still in full bloom September 10, 1907. Mrs. Owen mentions one patch in the southern part of the town and one at Siasconset, both of which had existed for some ten years prior to 1886.

Lysimachia quadrifolia L.

In thickets and open ground, common. In dry exposed places it is often dwarfed, with leaves greatly reduced in size; a form with deeper green and much broadened leaves is occasionally found in shade and richer soil. First flowers June 13, 1908; June 16, 1910; June 27, 1912.

Lysimachia terrestris (L.) BSP.

Common in low grounds and along pond shores. Flower buds June 15, 1908, but no open flowers up to June 20; first flowers June 23, 1910; June 27, 1912.

Lysimachia Nummularia L.

Naturalized at several places in and near the town; in abundance below the railroad embankment near Orange Street. First flowers June 18, 1908; June 18, 1910; June 28, 1912.

TRIENTALIS AMERICANA (Pers.) Pursh.

Common in shaded thickets and having a very brief flowering period. First flowers June 1, 1909, few flowers remaining June 9; no flowers seen in any year after the middle of June.

* GLAUX MARITIMA L.

In Rhodora (4: 215–216. 1902) Dr. Fernald, publishing his description of *Glaux maritima* var. *obtusifolia*, attributes the plant to Nantucket—"Aug. 18, 1878 (*Faxon*)." At that time there was no reason to suppose that the Faxon specimens thus cited might have become incorrectly labeled, but it is now thought that quite possibly such a mishap may have occurred. Mr. Floyd has acquainted me with what is known of the history of these Faxon specimens. They were contained in a bundle of unmounted plants collected by Mr. Faxon which, after his death, were turned over to the Gray herbarium. The specimens were folded in a sheet containing no label but bearing on the outside the pencilled record in Mr. Faxon's hand "Nantucket, Aug. 18, 1878." The bundle was made up of duplicates from the Faxon herbarium which, however, contained no corresponding specimens of this *Glaux* although it did possess examples of the plant collected at Plymouth, Massachusetts, only one week before the day when Mr. Faxon collected on Nantucket. These facts make it appear not at all improbable that, by some mischance, duplicates of the Plymouth collection had been passed along in a sheet that had been inadvertently labeled or, perhaps, previously used for some Nantucket specimen. At all events the Nantucket record must rest under reservations unless established by the future discovery of the plant on the island.

There is an earlier record of this species from Nantucket which is more certainly an erroneous one. The name appears in Mrs. Owen's first list of Nantucket plants, which was published in Godfrey's "Island of Nantucket," etc., 1882. It was omitted from her completed list of 1888. An explanation of this is given by Mr. Floyd who tells me that in a letter received by him from Mrs. Owen, dated May 12, 1909, the writer declares, "as for *Glaux maritima* I repudiate utterly at this time the insertion of it in the Godfrey catalogue."

By all this it appears that there is no unquestioned evidence

that *Glaux maritima* has ever been found on the island of Nantucket. Nevertheless it may not properly be omitted from the present catalogue since it has been collected in the County of Nantucket on the nearby island of Tuckernuck, where it was found in abundance by Mr. Joseph A. Cushman in 1909 and 1910 (Rhodora 13: 105. 1911). A specimen of this collection, kindly given to me by Mrs. Albertson, seems to be quite fairly representative of the smaller-leaved and widely branched typical state of the plant as Mr. Cushman has reported. It is to be noted in this connection that the Faxon specimens labeled for Nantucket, of which there is an excellent sheet in the herbarium of the New York Botanical Garden, are pronounced examples of the *obtusifolia* form of the species.

ANAGALLIS ARVENSIS L.

Very common in fields, by roadsides and on brackish sandy shores; often growing thickly in once cultivated tracts and disturbed ground. First flowers June 13, 1911, June 17, 1908, June 20, 1910, June 30, 1912; blooming through September.

PLUMBAGINACEAE

LIMONIUM CAROLINIANUM (Walt.) Britton.

Common in salt marshes. Some flower buds showing color July 13, 1912; in full flower through September.

OLEACEAE

SYRINGA VULGARIS L.

Often persisting and spreading about abandoned grounds and by roadsides. In bloom as late as June 12, 1911.

* FRAXINUS AMERICANA L.

Among a growth of pines, almost a woodland, on the Surfside road, about a mile from the town, are eight or more white ash trees scattered through an elongated area of perhaps seventy-five yards. In 1907 these trees were from eight to fourteen feet in height, the larger trunks fifteen inches in circumference. Some of them had been at one time chopped off close to the ground and had produced a second growth of tall shoots. This tree is certainly not indigenous to Nantucket and there can be no doubt

that these were planted many years before. The larger pines about them were fully twenty feet in height. Other white ash trees, evidently planted, grow in open ground near the cemeteries on the southeast side of the town.

Note.—Fine examples of the European ash (*Fraxinus excelsior* L.), some of them of large dimensions, may be seen along North Water Street and other streets of the town. They fruit prolifically, producing green clusters of samaras early in June, and seed themselves freely, growing up into saplings here and there in undisturbed places. After the severe winter of 1912 the upper branches of most of these trees having a northern exposure had been winter killed while those in more protected situations were uninjured. Vernation is late and, in backward seasons, the trees appear still quite leafless as late as the end of May.

GENTIANACEAE

CENTAURIUM SPICATUM (L.) Fernald.

Erythraea spicata (L.) Pers.

First recorded from Nantucket, and from America, in 1841, by William Oakes in Hovey's Magazine (7: 178, as *Erythrea Pickeringii* Oakes) having been collected in September, 1829. It grows along the borders of salt meadows and small tidal ponds, and is found along the north side of the island in Shimmo, Shawkemo, Quaise and Pocomo at numerous points over a distance of about three miles, and was collected by Mr. Walter Deane, Sept. 10, 1885, at Coskaty, some two and one half miles further towards the northeast. I have also found it on Little Neck, on the western side of the island, the extent of its range thus covering a distance of some ten miles.

The young plants may be detected before the end of June (June 29, 1912, largest plants three inches high). In full flower and with mature fruit August 16, 1906; September 5, 1904; still in bloom September 21, 1909.

SABBATIA CAMPANULATA (L.) Torr.

S. gracilis Salisb.

Shores of Almanac Pond and in wet places, also under fresh water conditions, at one or more stations in Squam. Plants ten inches high June 25, 1910; at the same place only two to three

inches high July 11, 1912; still in flower September 19, 1907; no flowers remaining September 16, 1899.

In the herbarium of Columbia University is a specimen from Nantucket collected by T. A. Greene in 1827, which is doubtless the oldest existing specimen of any Nantucket plant. It is labeled in Dr. Gray's hand "*S. stellaris*, Torr. & Gray Fl. N. Am."

The species was first recorded from Nantucket by Professor Edward Hitchcock in his "Report," edition of 1833, under the name *Sabbatia stellaris* Pursh. It was again reported by Mr. Oakes in Hovey's Magazine for May, 1841 (7: 180) where it was referred to *Sabbatia campanulata* Torr. (*S. gracilis* Salisb.), having been again collected by Dr. James W. Robbins "in moist hollows in Squam, in Mr. Greene's locality, Sept., 1829." Dr. Gray, in Synoptical Flora, confirmed this determination of Oakes, referring to the Nantucket plant as *Sabbatia gracilis* Salisb., "an ambiguous form."

The Nantucket plant, while in many examples quite typical, is mostly reduced in size and little branched, with the leaves in many cases relatively short and broad, frequently, indeed, exactly oval throughout, or the lower ones ovate. Precisely similar forms are frequent on Long Island, where the perfectly typical plant is locally common. It is interesting to note that *Sabbatia stellaris* Pursh occurs on Martha's Vineyard.

The specific distinctness of *Sabbatia campanulata* (L.) Torr. from *S. stellaris* Pursh seems to be not well supported by the characters that have been mainly relied upon for its separation. No points of difference that are at all constant are to be found in the more or the less divided style, the longer or the shorter calyx lobes, the broader or the narrower leaves. Actually all of these differences are unstable in a very marked degree. Much less so are two other characters which, indeed, seem to be almost always sharply distinctive although they have been little emphasized in descriptions. In *S. stellaris* the main stem leaves, broadest at or above the middle, are distinctly narrowed to the base and the usually acute apex, and the entire plant, unless carefully pressed, readily turns black in drying. *Sabbatia campanulata*, on the contrary, shows little or no discoloration on the herbarium sheet, and the commonly obtuse leaves, linear, linear-oblong, oval or, low

on the stem, actually ovate, are broadly sessile or subclasping. It is also worthy of remark that the leaves of *S. campanulata*, although the more fleshy in life, become more membranous in the dried specimen and more distinctly reticulate-veined.

BARTONIA VIRGINICA (L.) BSP.

Bogs and low grounds, also on the dry plains towards the south shore. Plants three inches high June 29, 1912; in full flower August 6, 1906, continuing in bloom through September. The corolla is subject to a noteworthy degree of variation both in size and form, its lobes varying from either broadly or narrowly oblong to spatulate, from entire to denticulate, and from truncately obtuse to mucronulate, or even tapering acute; anthers yellow, mucronulate, about 1 mm. long; capsule 4–6 mm. long, 2–3 mm. wide, remaining united at the apex, and septicidal below the undivided stigma. In the two following species the capsule splits into more or less spreading valves.

There is a late season form of *Bartonia virginica* that differs strikingly in appearance from the commoner form of the plant especially in its earlier flowering stage; the broadened lobes of the corolla have become rose purple, sometimes of an actually bright shade nearly throughout, and the enlarged ovoid capsule, 2.5–3 mm. in diameter, has by its increased width dilated the stigma to a broadly pyramidal instead of the usual columnar form. In cold sphagnum bogs a very small and delicate few-flowered form is sometimes found in which the cauline bracts, and even the flowers, are alternate.

* BARTONIA PANICULATA (Michx.) Robinson.

Occasional or frequent in damp or wet shaded thickets, straying out into open bogs; locally common about the borders of Tom Never's Swamp. In full flower August 31, 1904, continuing in bloom through September. Corolla white, 3–4 mm. long, the lobes lanceolate and acuminate to ovate-oblong and acute; capsule ovoid, 3–4 mm. long.

* BARTONIA IODANDRA Robinson.

This little known plant described from Nova Scotia by Dr. B. L. Robinson, in 1898, proves to be also a plant of Nantucket, where it shows clearly the characters that Dr. Robinson has

pointed out and that would seem to give it adequate standing as a species. It is found also on Martha's Vineyard and apparently, also, on Long Island, not always, however, perfectly maintaining the characters of its typical form, and certain rather dubious examples undoubtedly raise the question whether it may not be intergradient with *Bartonia paniculata*. In certain of its forms having the pedicellate branches opposite or nearly so it has so much the aspect of *B. virginica* that it might easily be mistaken for that species, but it is always to be distinguished from it by much smaller anthers and distinctly two-lobed instead of entire stigma. In *B. virginica* the mucronulate anthers are 0.75–1 mm. long, and the stigma is closely united to the apex; in *B. iodandra* the obtuse anthers are only 0.5 mm. or less in length and the stigma is bifid or cleft into two evident or even divergent lobes. The anthers of *B. paniculata* are similar to those of *B. iodandra*, perhaps slightly larger, but the lobes of the stigma, in the specimens at hand, are more contiguous and the stigma itself thicker and more depressed. In its most distinct form *B. iodandra* is a smaller plant than *B. paniculata*, of stricter habit and simpler inflorescence, the pedicels shorter and straighter and frequently opposite or nearly so; it differs also by larger flowers (4–6 mm. long) and capsules that are oblong rather than ovoid and bear stigmas that are longer and more distinctly two-lobed. It is quite possible, however, that the form of the capsule and of the stigma varies considerably with the degree of maturity as is the case with *B. virginica*. The corolla is commonly of membranous texture, sometimes almost translucent, and a correlated thinness of tissue is seen in the calyx lobes which tend to spread or recurve at the tip. In *B. paniculata* there is usually little evidence of the purplish coloration that so readily invades the tissues of *B. iodandra*, coloring the stems and often, but not always, the mature corolla, and, in the anthers sometimes intensifying into a deep maroon shade. But this coloring is not a constant character. The anthers may be either clear yellow with purple filaments or deep purple with the filaments yellowish. In *B. paniculata* the filaments are often faintly purplish and, rarely, the anthers and even the corolla may show a perceptible purplish tinge.

MENYANTHACEAE

MENYANTHES TRIFOLIATA L.

Mrs. Owen's catalogue bears record that this plant was found in Maxcy's Pond in 1853. It has remained there to this day in a secluded corner of the pond where, in 1909, it spread over an area not less than thirty yards in greater extent. I know of it also at three other stations on the island: in Shawaukemmo meadow; in a wet bog on Little Neck, where there is much of it, and in Round O Swamp, a circular bog perhaps one hundred yards across, set in the open on the western side of the island. So abundant is it here that, in early June, before becoming hidden by taller growing plants, its crowded leaves overspread the swamp in one unbroken level of dark bluish green, made more striking to the eye by a wide encircling rim of golden green from the budding leafage of the investing shrubbery. Here on June 1, 1909, it appeared to have passed entirely out of bloom until my field glass revealed a few plants in the very middle of the swamp still in full flower. The following year three weeks later in the season it was completely screened from view by a taller growth of *Calamagrostis* and *Decodon*. Found at one station on Martha's Vineyard.

NYMPHOIDES LACUNOSUM (Vent.) Kuntze.

Lymnanthemum lacunosum Griseb.

In many of the fresh water ponds. Just in flower June 15, 1908, June 27, 1910; in full flower July 6, 1912, on the eastern side of the island, not yet quite in flower on the western side July 10. Occurs on Tuckernuck.

APOCYNACEAE

* VINCA MINOR L.

Sparingly escaped from cultivation in and near the town. In full flower June 4, 1911.

APOCYNUM ANDROSAEMIFOLIUM L.

Occurs sparingly on the eastern side of the island in Pocomo and Squam and near Siasconset. In full flower near Wawinet July 8, 1912. Corolla brightly pink tinged, the largest 6.5 mm. long, spreading 8 mm.

*APOCYNUM MEDIUM Greene.

This species, the most characteristic dogbane of Nantucket, is frequent about the borders of thickets or in open ground throughout the eastern side of the island from Monomoy to Squam and Siasconset and on the South Pasture. On the western side I have seen it only by the roadside near Maxcy's Pond. Leaves beginning to unfold June 2, 1909; just in flower June 29, 1912, and still in flower July 11. It exhibits pronounced variations, developing both narrow-leaved and broad-leaved forms, and varies from nearly glabrous to almost hoary pubescent. The leaves, sometimes as large as 11 cm. long and 6 cm. broad, are commonly ovate-oblong and acute, but vary from ovate to lanceolate and tapering acute, to broadly oval, elliptic or oblong and obtuse, and may be either narrowed, rounded or subcordate at the base and subsessile or on slender petioles 8 mm. long. The flowers are always more or less suffused with clear pink. In an unusually pubescent form the corollas were puberulent on the inner surface.

APOCYNUM CANNABINUM L.

Not uncommon on the eastern side of the island from Polpis to Pocomo and Squam. Just in flower July 4, 1912. Several rather distinct varieties occur. One, found in dry soil near Wawinet, has white, urceolate corollas 3–3.5 mm. long, the lobes shorter than the tube, their tips finally spreading. A taller variety with longer and narrower leaves on more slender petioles becoming 12 mm. long, has greenish to definitely yellow corollas 4 mm. long with erect lobes the length of the tube, the bluish green leaves glaucescent on the upper face; this grew luxuriantly about a low meadow thicket in Squam. In yet another form with short-lobed white corolla, the narrowly oblong leaves are very short-petioled or subsessile and slightly narrowed to a cordate base. In all of these forms the leaves are more or less pubescent beneath and the cyme quite glabrous to slightly pubescent.

* APOCYNUM PUBESCENS R. Br.

Occurs sparingly in Squam. Not quite in flower June 15, 1908. Inflorescence and leaves beneath densely white tomentose; the upper part of the stem and the younger leaves on the upper

surface hoary pubescent; leaves dark green above, mostly ovate to elliptic or oval, rounded at base, the petioles white tomentose.

* APOCYNUM SIBIRICUM Jacq. ?

Scattered along a thicket bordering the west side of Tom Never's Pond. Inflorescence just appearing June 24, 1910; first flowers July 2, 1912. Plants becoming at least 6 dm. tall, pale green and glaucous, glabrous throughout, even the unfolding leaves showing no trace of pubescence; leaves narrowly oblong to ovate-lanceolate, acute, becoming 14 cm. long, rounded at the base, short-petioled, or the lower subsessile and cordate; corolla small, creamy white, the short lobes obtuse; calyx-lobes elongated, linear-lanceolate, tapering and flexuous, ciliolate towards the end when young.

Referred to *A. sibiricum* in the broad sense in which the name seems to be commonly employed. It is scarcely possible to believe, however, that this Nantucket dogbane belongs to the same species as the diffuse small-leaved plant of gravelly river shores (*A. album* Greene), now merged with *A. sibiricum*, nor can it be referred without much reservation to typical *A. sibiricum* (*A. hypericifolium* Ait.), an erect, often tall glaucous species with cordate-clasping mostly oblong and obtuse leaves. It is quite possible that it may represent some one of a number of species recently announced by Professor Greene (Leaflets II: 169–174. 1912).

ASCLEPIADACEAE

ASCLEPIAS TUBEROSA L.

So far as known the butterfly weed has never been other than a rare plant on Nantucket, although it is locally common on Martha's Vineyard, and abundant on Chappaquiddick Island. The herbarium of the Maria Mitchell Association contains a flowering specimen collected near the old mill July 17, 1896, and one from the Friends Burying Ground, July, 1889. Here on June 19, 1908, grew a solitary tuft of eight stems all bearing clusters of flower buds. Of late years it seems to have been found nowhere else on Nantucket than at this station.

* ASCLEPIAS PURPURASCENS L.

Capaum Pond, July 10, 1912,—a group of eleven plants in full flower growing about midway on the face of the bluff or high

bank on the west side of the pond. Less than one hundred feet distant the bluff from top to bottom was clothed with a dense growth of the common milkweed, also in full bloom.

ASCLEPIAS PULCHRA Ehrh.

Common in low grounds. First open flowers July 10, 1912; in full flower August 15, 1906; no flowers left August 27, 1904. A number of plants were seen having some of the leaves in whorls of three and of four.

A well-marked variety of this milkweed is common on Nantucket, perhaps even more so than the ordinary form. It is characterized by denser white-tomentose pubescence, shorter internodes and much broader ovate to ovate-oblong, often cordate leaves, sometimes as much as 8 cm. in width.

ASCLEPIAS AMPLEXICAULIS J. E. Smith.

Not an abundant, but a characteristic plant of Nántucket widely scattered over the dry plains and commons. Umbels of close buds June 17, 1910; large flower buds June 30, 1912; first flowers July 9, 1912.

ASCLEPIAS EXALTATA (L.) Muhl.

Rare. A single small plant was found near Almanac Pond, September 21, 1907. The species was not seen again until July 8, 1912, when a cluster of tall plants in full flower was found in a hillside thicket in Squam near Eatfire.

ASCLEPIAS SYRIACA L.

Common, often forming large colonies in fields and along banks and roadsides. A few inches high May 30, 1909; flower buds appearing June 20, 1908; umbels of large buds June 15, 1910; first flowers June 27, 1910, June 29, 1912.

CONVOLVULACEAE

*IPOMEA PURPUREA (L.) Lam.

Occasional in waste places. In flower August 11, 1906, September 18, 1908.

* CONVOLVULUS SEPIUM L.

In a cultivated field near Miacomet Pond June 3, 1909. Not in flower, but unmistakably the introduced European plant.

Glabrous, leaves dark green, thickish, obtuse or broadly acute, the approximate basal lobes directed backward or even incurved, broad and rounded or obtusely angled. This European bindweed is said to intergrade with our native species. However this may be the two plants seem to follow independent trends of development that take them into a wide divergence. The flowers are even more at contrast than is the foliage. The commonly white corolla of the introduced species is of much thicker texture and of a different form than that of our native plant, the limb less expanded, the tube shorter and broader and more abruptly narrowed at its insertion; also the anthers are larger and their filaments broader basally and more abruptly narrowed above; the peduncles are more decidedly quadrangular, even wing-margined, and the bracts are larger, commonly clasping the corolla for more than half its length. I have usually found it a local and not at all a common plant.

CONVOLVULUS AMERICANUS (Sims) Greene.

In low thickets twining on the shrubbery, sometimes long trailing on gravelly or sandy shores. Nearly glabrous to slightly pubescent, the leaves attenuate or acuminate, the basal lobes divergent, entire or sharply angulate. Not always well defined from *C. repens* and apparently intergrading with it. Nevertheless the two plants when developed in their proper types are strikingly distinct.

* CONVOLVULUS REPENS L.

Very common, mainly along brackish shores and the borders of salt marshes. Just in flower June 15, 1908, June 15, 1910. Typically densely white pubescent or velvety throughout, the basal lobes of the leaves parallel and entire or nearly so.

CONVOLVULUS ARVENSIS L.

Occasional along fences in the town and suburbs; Quaise. Just in flower June 19, 1910, July 6, 1912.

CUSCUTA GRONOVII Willd.

Infrequent, but found here and there throughout the length of the island. The orange colored stems become noticeable by the middle of June and the flowers appear late in August and early in September.

A form collected in Polpis, September 17, 1907, growing on *Solidago* and *Boehmeria*, has diverging styles becoming 3–4 mm. in length, and stamens nearly as long as the lobes of the corolla; the scales of the corolla are parted and cleft into a sparse fringe and the depressed-subglobose capsule is not at all umbonate but, on the contrary, definitely flattened at the top.

BORAGINACEAE

* LAPPULA LAPPULA (L.) Karst.

Waste yard on North Water Street, June 17, 1910, a single large plant just in flower; Surfside, July 4, 1912, a number of plants in full flower about an abandoned chicken paddock.

* AMSINCKIA INTERMEDIA F. & M.

A number of plants in scattered growth with the preceding near Surfside, in full flower and fruit July 4, 1912. Plants erect, becoming 6 dm. high with flowering spikes 2 dm. long; corolla 1.25 cm. long, spreading 7 mm., orange yellow, reddened in the throat.

PNEUMARIA MARITIMA (L.) Hill.

Although the sea lungwort has long been known to grow on Nantucket, reaching there the southern limit of its range, it seems to have remained always one of the island's rarer plants and never to have established any permanent colony. Nor is it known that more than a few plants have ever been found together on the island. It seems to appear sporadically, and to disappear, at widely separated points along those miles of seashore that, it might be thought, would offer good encouragement to its continued growth. These circumstances of its occurrence suggest that its seeds may come to the island from time to time by some natural agency of dispersion but that the plant is unable to overcome some condition in the environment not quite favorable to its particular needs. Mrs. Owen has recorded the occurrence of a single plant on the north shore at Brant Point, one or two on the south shore, and a few large plants on the southeast shore between Siasconset and Sancoty. I, myself, have met with it only twice; on the sand strip between Sachacha Pond and the ocean, two small sterile plants, September 6, 1904; and at Coskaty, a solitary plant in full flower, June 12, 1911.

* MYOSOTIS SCORPIOIDES L.

Myosotis palustris Lam.

Established by the roadside along a rill flowing from the fountain erected in 1900 in memory of the mother of Benjamin Franklin, who was born near this now uninhabited spot 233 years before. It was found there by Mr. Floyd in 1906, and by me September 14, 1907, when in some of the plants young racemes were concealed within the terminal leaves. First flowers June 6, 1909; in full bloom June 10, 1908, and June 7, 1910; a few flowers remaining June 28, 1912. Doubtless, it may be supposed, the forget-me-not had been planted at this memorial fountain, perhaps at the time of its dedication, but I was unable to ascertain that this was known to have been its origin there.

* MYOSOTIS ARVENSIS (L.) Hill.

A few plants were found by Mrs. Flynn in a field by Orange Street in 1895. A specimen sent to me had been collected June 29, and bore both flowers and fruit.

* LITHOSPERMUM ARVENSE L.

A few plants in a waste yard on North Water Street in full flower and fruit June 17, 1910. A single plant in full flower was collected the same year by Miss Grace B. Gardner by a sandy roadside south of the town.

ONOSMODIUM VIRGINIANUM (L.) DC.

Not at all a rare plant on Nantucket, as has been supposed, but confined to the northeastern quarter of the island where it is locally common in dry open ground through Squam, extending into Pocomo; farther west two plants have persisted for several years on a dry knoll near Acquidness Point. It is also locally common on Chappaquiddick Island, Martha's Vineyard. Many unopened flower buds June 12, 1909; first flowers June 15, 1908; in full flower June 20, 1910; July 11, 1912.

* SYMPHYTUM ASPERRIMUM Donn.

Meadow near the Springfield House 1895 and 1906, F. G. Floyd. The antecedent of this station is perhaps a group of plants that has survived for years in a neglected yard not far away on North Water Street where it would appear to have been originally planted. Freshly in flower June 15, 1910.

ECHIUM VULGARE L.

Established along Orange Street in the eastern outskirts of the town. The plants have been numerous in some years, scarce in others, and have spread little since they were first seen in 1904. Mrs. Owen has recorded that a few plants were found near Siasconset in 1887. First flowers June 19, 1910; in full flower June 28, 1910; August 5, 1906; September 11, 1907.

VERBENACEAE

VERBENA HASTATA L.

In low grounds; frequent throughout the northern half of the island where it is rather common in parts of Polpis and in Squam. Plants six inches high June 11, 1909; first flowers July 10, 1912; still in full flower September 11, 1907. The Nantucket plant is mainly the form having leaves cleft on each side near the base.

* VERBENA URTICIFOLIA L.

Barnyard, 1896, Mrs. Mabel P. Robinson, fide F. G. Floyd. Doubtless introduced. Occurs sparingly on Martha's Vineyard.

LABIATAE

TEUCRIUM LITTORALE Bicknell.

Common along salt and brackish meadows and by pond shores. Plants very small May 30, 1909; not yet any flower buds July 14, 1912; in full flower August 16, 1906.

A dense growth of this species that covered a pile of stones by a fieldside in Polpis, wholly away from the influence of salt water, consisted entirely of plants bearing pure white flowers.

* TEUCRIUM OCCIDENTALE A. Gray.

A cluster of plants not yet out of bloom was found growing in a lumber yard on the wharves September 5, 1904. The species was found again on Nantucket, August 1, 1910, by Miss Grace B. Gardner, who has sent me a specimen in full flower collected in waste ground on Silver Street near Milk Street.

TRICHOSTEMA DICHOTOMUM L.

Common in sandy soil, and often abundant in old fields. It blooms in August and through September.

SCUTELLARIA LATERIFLORA L.

Frequent or rather common in wet places. In full flower September 6, 1904.

SCUTELLARIA GALERICULATA L.

Common in boggy places and along pond shores. First flowers June 22, 1910; in full flower June 28, 1912, and in early September, 1904; no flowers left September 11, 1907.

MARRUBIUM VULGARE L.

Occasional by street sides and in waste places; abundant in the jail yard; Monomoy farm; one cluster at Madequecham Pond. In full flower June 16, 1908, June 16, 1910.

NEPETA CATARIA L.

The familiar catnip may be seen in cultivation in old Nantucket gardens, but is rather scarce as a wild plant. It springs up as a casual weed in the town and is found sparingly in waste places and farmyards in the suburbs; seen at one farmyard in Madequet. At one spot in Pocomo it grew in abundance far from any dwelling but where evidently a small house had stood many years before. No flower buds up to June 15, 1908; not yet in flower June 29, 1912; in full flower July 10, 1912, and through September.

GLECOMA HEDERACEA L.

Established at a few places in the town and suburbs. In full flower June 7, 1908, June 9, 1911.

* PRUNELLA VULGARIS L.

Occasional on lawns in the town; evidently introduced, probably with grass seed.

PRUNELLA PENNSYLVANICA Willd.

Meadows, fields and roadsides. I have never anywhere seen it more abundant or more brightly conspicuous when at its height of bloom. First flowers June 7, 1908, June 9, 1909, June 9, 1911, June 16, 1910; still in bloom late in September.

GALEOPSIS LADANUM L.

This hemp nettle is noted from Squam in Mrs. Owen's catalogue, wherein also the name *Galeopsis Tetrahit* L. appears, but without mention of any locality. Nothing further is known of either species as a Nantucket plant.

LEONURUS CARDIACA L.

Frequent or rather common in barnyards and waste spots, especially in and near the town; Quaise, Pocomo; Madequet. No flowers up to June 21, 1908; freshly in bloom June 28, 1912; past flowering September, 1907.

LAMIUM AMPLEXICAULE L.

An occasional weed in town gardens and sometimes abundant in once cultivated fields in the suburbs; Shawkemo; Quaise. In full flower May 30, 1908; June 3, 1911; June 15, 1910; small closed flowers September 13, 1909.

STACHYS HYSSOPIFOLIA Michx.

Wigwam Pond in Saul's Hills. In full flower August 6, 1906, thriving in water up to six inches in depth, smaller and of less vigorous growth along the shore. I have not myself seen it elsewhere on Nantucket although Mrs. Owen speaks of it as rather common by some of the Polpis ponds. The plant is the typical narrow-leaved form.

* SALVIA OFFICINALIS L.

A single tall plant, nearly past flowering, growing among weeds and briers on Sunset Hill, June 27, 1912.

HEDEOMA PULEGIOIDES (L.) Pers.

Nothing is known of the pennyroyal on Nantucket beyond its inclusion in Mrs. Owen's catalogue. There is not the least improbability in the record, but if the plant grows on the island today it must be extremely rare. It occurs locally on Martha's Vineyard.

* MELISSA OFFICINALIS L.

A few plants in a neglected grassy yard on North Water Street June 11, 1911, July 7, 1912. Miss Grace B. Gardner writes me that she has also collected this plant on Nantucket.

KOELLIA FLEXUOSA (Walt.) MacM.

Occurs very sparingly in Squam and also at a station less than a mile east of the town, where it was first found September 15, 1899, then in full flower. Here it grew thickly among the rank vegetation about a small pool.

In the first edition of Gray's manual this species is reported

from Nantucket, the northern limit of its then known range. Mrs. Owen remarks of this in her catalogue that the Nantucket locality is unknown and that the plant had never been "found by collectors of the present day." Quite possibly the station east of the town had been discovered by some botanist over half a century ago and was the basis of Dr. Gray's record.

KOELLIA VIRGINIANA (L.) MacM.

Frequent in Squam, at scattered stations, extending towards Pocomo and south to Sachacha Pond, also sparingly near Siasconset. Nearly in bloom July 8, 1912; still in flower September 16, 1899; no flowers left September 21, 1907.

KOELLIA MUTICA (Michx.) Britton.

Frequent at the eastern end of the island, in Squam, and in "The Woods" on the western side; it is also found near the middle of the island about the head of Miacomet Pond. First flowers July 8, 1912; in full flower in August and as late as the middle of September.

The *Pycnanthemum incanum* Michx. of Mrs. Owen's catalogue doubtless refers to this species.

* KOELLIA VERTICILLATA (Michx.) Kuntze.

Found sparingly at several stations in Squam, near Wauwinet growing with *Koellia virginiana*. First flowers July 8, 1912. The Nantucket plant is distinctively *Koellia verticillata* as set apart from the more southern *Koellia Torreyi* (Benth.) Kuntze. Its lanceolate leaves vary from entire to serrate with few but distinct cartilaginous-tipped teeth, and the uppermost leaves, with the floral bracts, are canescent. It seems to be always closely associated in growth with *K. virginiana* in a part of the island inhabited also by *K. mutica*, and its aspect and characters appear to be so obviously intermediate between these two plants, tending now towards the one and now towards the other, that its status as an independent species, at least on Nantucket, assuredly becomes open to question.

* THYMUS SERPYLLUM L.

Collected on Nantucket in August, 1906, by Miss Mina K. Goddard. A specimen in flower and fruit was kindly sent to me for examination by Mrs. Flynn.

LYCOPUS UNIFLORUS Michx.?

Lycopus communis Bicknell.

Common in low grounds. Plants very small May 30, 1908, June 3, 1911; in full flower August 16, 1906, September 12, 1907. A distinct appearing form, observed especially at Maxcy's Pond and Capaum Pond, becomes much branched from a woody non-tuberous base and produces numerous slender and widely branched tuber-bearing purple stolons, sometimes three feet in length. The dark green divergent leaves, sharp serrate and acuminate, are numerous and brought close together by the very short internodes, and the uppermost are usually strongly purplish tinged; the sepals are narrower and more acute than in the typical plant, sometimes even narrowly lanceolate, suggesting those of *Lycopus rubellus* Moench. This plant bears a strong resemblance to forms of *Lycopus virginicus* L. and seems to approach it in some of its characters, but the corolla is dilated in the throat and has widely spreading lobes like that of the common species, of which it appears to be an extreme phase. The same form is found on Martha's Vineyard and on Long Island.

* LYCOPUS MEMBRANACEUS Bicknell.

Lycopus uniflorus Michx.?

Uncommon, occurring in damp or wet shaded thickets. Polpis, August 6, 1906, in full flower; Quaise, September 11, 1907, growing with the dwarf cornel; Pocomo, September 21, 1907, some late flowers.

Slender, often lax or decumbent, leaves very thin, cuneate-ovate, or narrower, often rhomboid, saliently coarse toothed, usually obtusely long-pointed; petioles slender, two or three times longer than the flower clusters; clusters looser and fewer flowered than in the preceding, the mature flowers distinctly pedicelled; calyx-lobes membranous, often very pale or whitened, commonly deltoid, obtuse or acute; the sinuses rounded; fruit pale in color when mature.

Remarkably distinct in appearance from the preceding species yet quite possibly intergrading with it. The ordinary shade form of the latter is, however, a plant not at all like *Lycopus membranaceus*. It is larger, stouter and of more luxuriant growth, with the internodes shorter and the more numerous leaves of thicker texture

and short-petioled or sessile; they are furthermore more oblong or ovate-oblong in general form, much less cuneately tapering at base, the teeth much less pronounced and, with the apex of the leaf, more acute; the flowers are much more numerous and shorter pedicelled and are formed into compact or globose clusters.

* LYCOPUS SESSILIFLORUS A. Gray.

A characteristic plant of Nantucket, growing in muddy wet places and about bog holes in all parts of the island. Young plants recognizable May 30, 1908; in full flower and fruiting well September 5, 1904; still in full flower September 21, 1909.

LYCOPUS AMERICANUS Muhl.

Common in low grounds and along Pond shores. Plants very small May 30, 1908; just in flower July 10, 1911; still in bloom September 12, 1904.

MENTHA SPICATA L.

Scarce; streetside near the wharves and at two stations in the suburbs of the town, also in a meadow in Madequet. Not seen in flower.

* MENTHA PIPERITA L.

Scarce; along Crooked Lane and at three other stations west of the town. Not seen in flower.

* MENTHA GENTILIS L.

Sparingly in waste ground west of the town September 20, 1899, last flowers; border of meadow at Consue spring July 10, 1912—a large form, the leaves conspicuously whitened along the veins, no signs of flowering.

* MENTHA CANADENSIS L.

Frequent or rather common in low grounds, often developing an unusual degree of somewhat villous white pubescence. Plants a few inches high June 4, 1909; in full flower at the end of August, 1904, and as late as September 18, 1899.

* MENTHA ROTUNDIFOLIA (L.) Huds.

Through the kindness of Mrs. Flynn, I have been enabled to examine a mounted specimen of this mint collected in full flower on Nantucket, August 19, 1895, by Miss Mina K. Goddard. The

leaves, which are short-petioled and low crenate-serrate, are thinner and less rugose and pubescent than in more characteristic examples of this variable mint; the spikes however are quite typically narrow, and interrupted below.

* MENTHA CRISPA L.

Found by Mrs. Flynn growing in quantity along a ditch near the harbor east of Union Street. Specimens sent to me were collected in full flower in August, 1895, and are perfectly typical. Apparently not previously reported from Massachusetts.

INDEX TO AMERICAN BOTANICAL LITERATURE

1906–1914

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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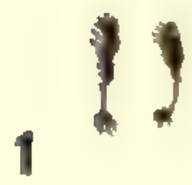

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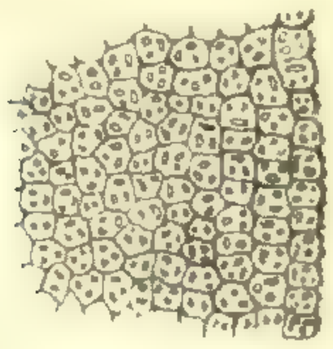

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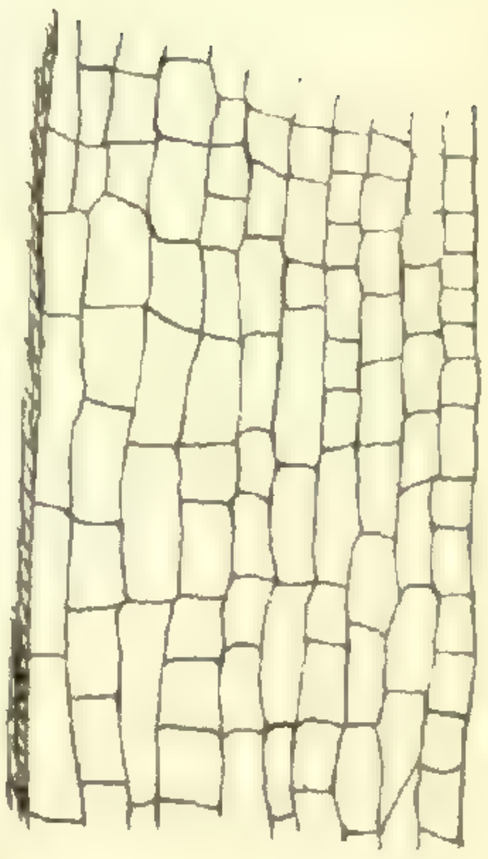

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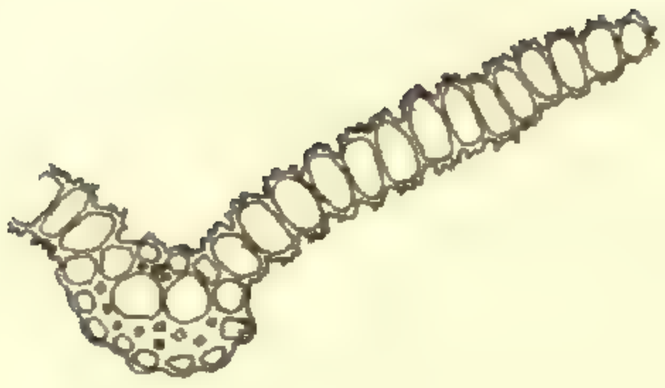

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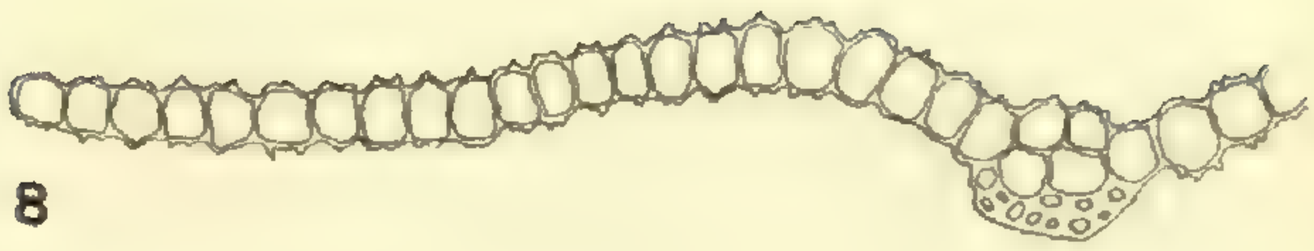

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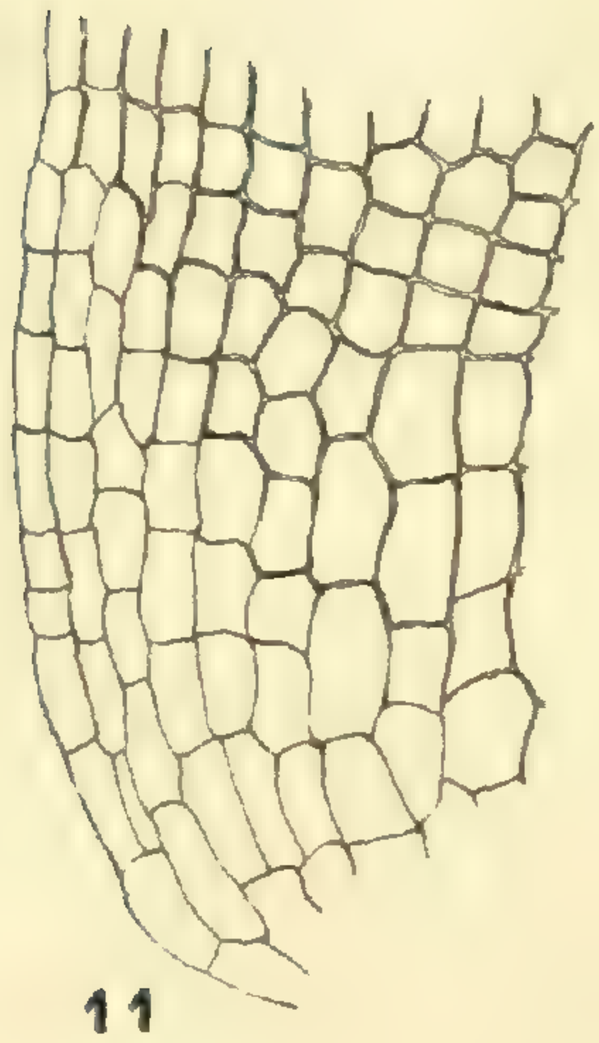

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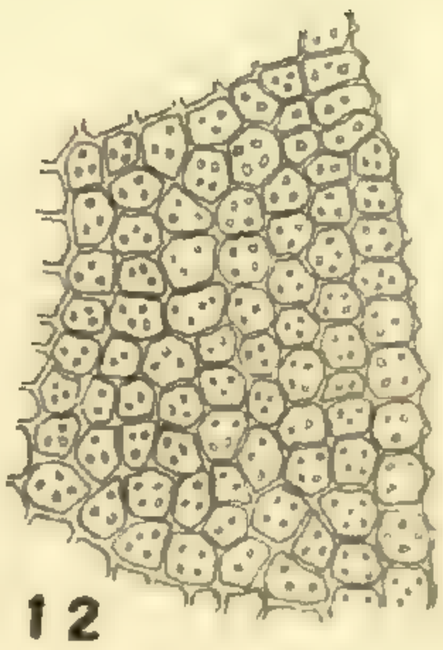

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R.S.W

1–6. HYOPHILA ULIGINOSA E. G. BRITTON
7–13. PHASCUM SESSILE E. G. BRITTON

Vol. 42 No. 2

BULLETIN

OF THE

TORREY BOTANICAL CLUB

FEBRUARY, 1915

A new North American Endophyllum*

J. C. Arthur and F. D. Fromme

(WITH PLATE 2 AND TWO TEXT FIGURES)

The genus *Endophyllum*, of which *E. Sempervivi* is the type and the best known example, is distinctive in that its spores, to all outward appearances aeciospores, being accompanied by intercalary cells and a peridium and borne in an Aecidium-like fructification, are in reality true teliospores that give rise to promycelia and basidiospores on germination, as Hoffman† and others have conclusively demonstrated. *Gymnoconia*, thought to be an aecial form until the recent notable work of Kunkel‡ on *G. interstitialis*, is to be considered an allied genus, in which the teliospores have intercalary cells but are not enclosed in a peridium. In both cases the vegetative mycelium is perennial in the tissues of the hosts and the life histories are completed with the production of a single spore form, the teliospore, in addition to the basidiospores and pycniospores.

During the past summer we have succeeded in demonstrating the *Endophyllum* character of *Aecidium tuberculatum* Ellis & Kellerm., a rust of the western prairies and uplands on malvaceous plants, especially *Callirhoë involucrata*.

The *Callirhoë* rust has been an object of investigation by the

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* Read before the Botanical Society of America at the Philadelphia meeting, December 29, 1914.

† Hoffman, A. W. H. Centralbl. f. Bakt. 2 Abt. **32**: 137–158. 1912.

‡ Kunkel, L. O. Bull. Torrey Club **40**: 351–366. *pl. 3*. 1913. Am. Jour. Bot. **1**: 37–47. 1914.

[The BULLETIN for January (**42**: 1–54, *pl. 1*) was issued January 29, 1915.]

botanical department of the Purdue Experiment Station for the past ten years and during a considerable part of this period infected plants of *Callirhoë involucrata* have been grown in the experimental garden at Lafayette. The probable *Endophyllum* character of the form was recognized at the first from certain features in the structure of the sorus, the perennial mycelium, and the failure of field studies to disclose any likely alternate stage. In order to test this assumption it was necessary to have material near at hand for germination and infection studies and Mr. E. Bartholomew of Stockton, Kansas, very kindly sent infected *Callirhoë* plants for this purpose. The first consignment of these plants was received in 1904 and they were subsequently grown in the garden three or four years, producing aecia each year. Germination tests of the spores made by the senior writer in 1907 disclosed only non-septate germ tubes (TEXT FIG. 1) and the conclusion was reached

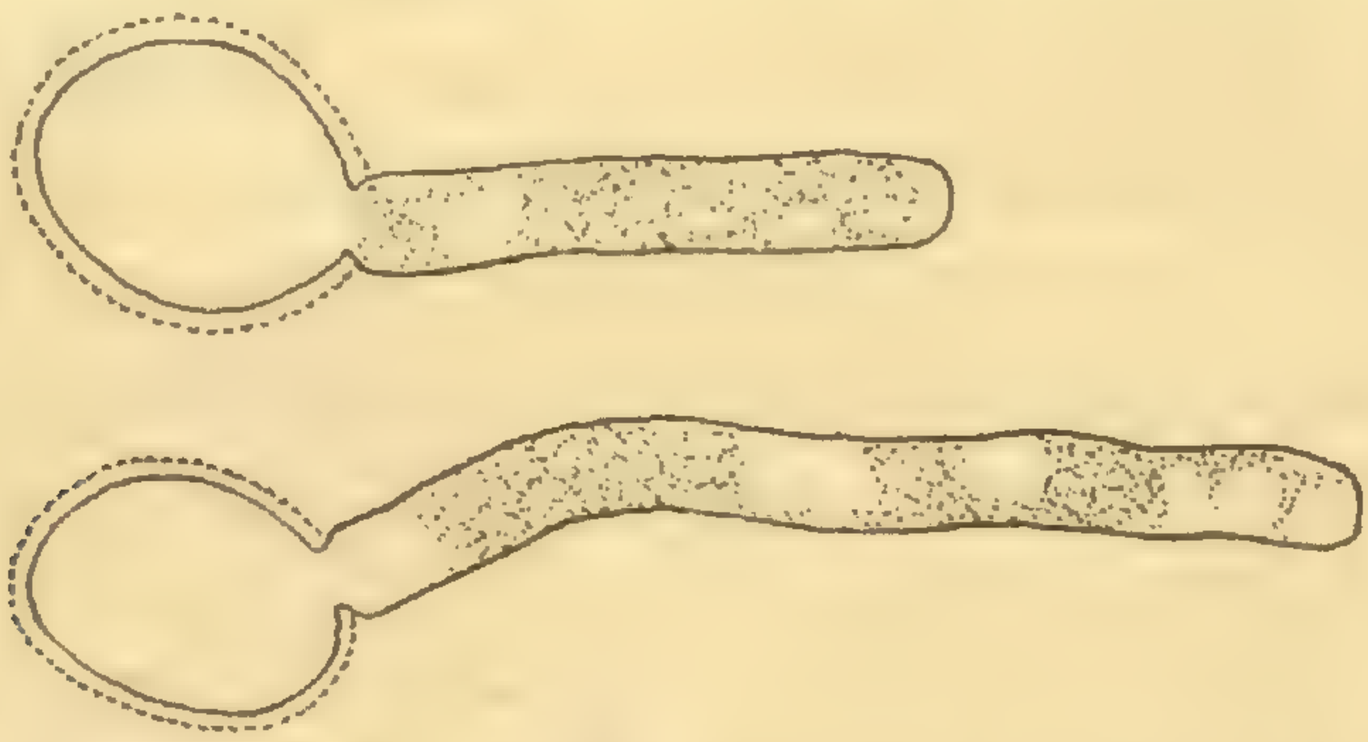

FIG. 1. Teliospores of *Aecidium tuberculatum* germinated in a Van Tieghem cell. After a drawing by F. D. Kern in 1907.

that the spores were true aeciospores and the structure an aecium in spite of the inferential evidence to the contrary. We now know that the method of germination commonly employed in such tests, the hanging drop of the Van Tieghem cell, was responsible for the failure to discover the true character of the germination.

Early in the present year of 1914 Mr. Bartholomew sent another shipment of infected plants of *Callirhoë involucrata* and germination tests were again instituted. The method of germination employed by Kunkel, sowing on the surface of a non-nutrient agar, was used with complete success. Promycelia and basidiospores were produced in abundance in the first test and in the score or more of subsequent tests that were made, proving conclusively that the spores are in reality teliospores.

With these results in mind a search was made for other aecia on malvaceous hosts that might be of a similar nature. An unnamed species of *Aecidium* on *Sidalcea* and *Althaea*, hitherto considered distinct from *Aecidium tuberculatum*, proved to be so similar morphologically that the identity of the two seemed most probable. The *Sidalcea* form had been tentatively connected with a grass rust, *Puccinia Deschampsiae*, from field studies in Colorado by Mr. E. Bethel, that were afterward inspected by Dr. F. D. Kern and the senior writer in company with Mr. Bethel. Mr. Bethel's field attempts to prove this connection, made at Eldora and Denver, Colorado, and reported to us, had, however, been unsuccessful. At our request, Mr. Bethel sent us, last September, plants of *Sidalcea candida* infected with the *Aecidium* in question. These spores on germination likewise produced promycelia and basidiospores (FIG. 7) identical with those of *Aecidium tuberculatum*. The identity of the two forms, therefore, seems certain.

FIG. 2. Distribution of *Aecidium tuberculatum* and its hosts. Diagonal lines indicate approximate distributions of *Callirhoë involucrata*, *Sidalcea candida*, and *S. neo-mexicana*; cross hatching shows areas covering known distribution of *Aecidium tuberculatum*.

The form is known on *Althaea rosea* from the single locality of Red Cloud, Nebraska, where it was collected by the Rev. J. M. Bates in 1910 and where the *Callirhoë* rust is reported as "everywhere." Although we have had no opportunity of testing the germination of its spores there is no real question of its identity with the *Callirhoë* and *Sidalcea* rust.

The type of *Aecidium tuberculatum* was collected by Mr. E. Bartholomew on leaves of *Callirhoë involucrata*, Rooks County, Kansas, September 15, 1887. It has since been found on this host at several stations on the prairies of eastern, central and western Kansas and southern Nebraska. The *Sidalcea* rust is known from several points in the mountains of central Colorado and from a single collection in south central Wyoming (TEXT FIG. 2).

The infection of the various hosts through the sowing of basidiospores has not so far been demonstrated but experiments are under way the results of which should be apparent next spring.

Pycnia are apparently obsolete in this species; a careful search of infected leaves and a study of microtome sections brought forth no traces of them.

The teliospores are normally one-celled, but occasional two-celled spores are produced and one or more of them may be found in any mount (FIG. 2). Their wall thickness, coloring and verrucose sculpturing is like that of the one-celled spores, from which they differ only in form and the presence of a horizontal median septum. They are found in microtome sections of the sori scattered among the one-celled spores in the upper part of the spore chains. Each cell contains two nuclei the products of the conjugate division of the two nuclei of the one-celled spores from which they arise by a vegetative development.

These two-celled teliospores of *Aecidium tuberculatum* are suggestive of those found normally in the genus *Pucciniosira*, which has catenulate, uniseptate teliospores accompanied by a peridium and borne in a cupulate telium that is to all external appearances a true, but diminutive, aecidium. The other morphological features of the sorus and spores of *Aec. tuberculatum*, especially the large, bullate sorus, the fragile, slightly differentiated peridium, and the breaking apart of the spore chains in older sori giving the impression that the spores are compacted without order are, however, characteristic of the genus *Endophyllum* to which it is, therefore, now referred.

Endophyllum tuberculatum (Ellis & Kellerm.) comb. nov.

Aecidium tuberculatum Ellis & Kellerm. Jour. Myc. 4: 26. 1888.

O. Pycnia unknown, probably not formed.

III. Telia aecidioid, hypophyllous and caulicolous, diffused, from a perennial mycelium, following the veins or covering large areas, round or elliptical, bullate, large, 0.5–1 mm. broad by 0.5–1.5 mm. long, yellowish or orange when fresh; peridium colorless, opening at first by a small apical pore, soon disappearing; peridial cells oblong, slightly larger than the teliospores, the outer wall smooth, transversely striate, 5–7 μ thick, the inner coarsely verrucose, thinner, 1–3 μ; teliospores angularly globoid or oblong, occasionally with a transverse, median septum, 16–26 by 18–30 μ; wall pale yellow, moderately thin, 1–2 μ, closely and rather prominently verrucose.

On *Althaea rosea* L.: Nebraska (Red Cloud, October 6, 1910, *Bates*).

On *Callirhoë involucrata* (T. & G.) A. Gray: Kansas (Rockport, now called Stockton, May 20, 1889 in Kellerm. & Swingle, Kan. Fungi *30*, May 22, 1894, Stockton, May 25, 1911 in Barth. N. Am. Ured. *302*, Rooks County, September 15, 1887, May 25, 1897 in Sydow, Ured. *1199*, June 2, 1902, Manhattan, May 1893 in Carleton, Ured. Am. *31*, all by *Bartholomew;* Osborne County, June 1891, *Brown;* Osborne, May 1894 in Rab.-Wint.-Paz. Fungi Eur. 4239, *Shear;* Decatur County, June 1892, *Hitchcock;* Wichita, June 7, 1893, *Carleton*); Nebraska (Red Cloud, May 2, 1903, May 9, 1903, May 14, 1911 in Barth. N. Am. Ured. *601*, *Bates*).

On *Sidalcea candida* A. Gray: Colorado (Eldorado Springs, August 19, 1909, Eldora, September, 1910, Lake Eldora, August 7, 1910, September 17, 1910, August 25, 1911, Tolland, October 29, 1910, September 20, 1914, all by *Bethel*; Routt County, July 16, 1894, *Crandall*).

On *Sidalcea neo-mexicana* A. Gray (*S. malvaeflora* Coulter in Bot. Rocky Mt. Region, not A. Gray): Colorado (Sulphur Springs, November 1910, August 14, 1910, *Bethel*); Wyoming (Seminole Mts., Carbon County, July 23, 1898, *E. & A. Nelson*).

Type collected in Rooks County, Kansas, on leaves of *Callirhoë involucrata*, *E. Bartholomew 25* (September 15, 1887).

DISTRIBUTION: from eastern Kansas and southern Nebraska to north central Colorado and southern Wyoming.

The germination stages of the teliospores of *End. tuberculatum* are similar to those described by Kunkel for *Gym. interstitialis* and by Hoffman for *End. Sempervivi.* The promycelium is formed at one end of the ellipsoid spore and usually attains its full length,

about 90 μ, before the septa appear. The promycelium is divided, as a rule, into four uninucleate basidiospore initial cells and a basal stalk (FIGS. 6–12). Each basidiospore initial cell gives rise to an ellipsoid basidiospore on a sterigma (FIGS. 7–9). Under suitable conditions the basidiospore germinates at maturity with a slender germ tube that may issue from the apex (FIGS. 6, 8) or from the base near the attachment of the sterigma (FIG. 9).

The common practice of germinating rust spores in the inverted drop of the Van Tieghem cell is undoubtedly the reason why the true character of the very common and much studied *Gym. interstitialis* remained obscure for so many years and Kunkel's discovery is attributable to the important departure in method of germination that he employed.

The production of basidiospores is dependent to a considerable degree on the exposure of the promycelium to a free air surface. If the teliospores are floated on an upright drop of tap water on a slide placed in a damp chamber basidiospores are freely formed, but if sown in an inverted drop of water in a Van Tieghem cell no basidiospores are produced and spore germination may be totally inhibited. A drop of a five percent non-nutrient gelatin may be substituted for the upright drop of water to secure greater stability. If spores are available in large quantities they may be dusted on the surface of water or non-nutrient gelatin or agar in a petri-dish. On a moderately hard agar the basidisopore initial cells produce germ tubes directly without the formation of basidiospores (FIGS. 10–13).

That the moisture and air relations under which teliospores are germinated have a marked effect on the character of their germination has also been shown by Klebahn,* who worked with teliospores of *Puccinia malvacearum*. He found that normal promycelia and basidiospores were produced if the spores were in contact with air and not surrounded by a film of water, but if surrounded by water with the air shut out only long thin tubes were formed.

There is perhaps no basis on which species with aecidioid telia can be distinguished from the aecia of long-cycle forms except in the behavior of their spores on germination. A perennial

* Klebahn, H. Zeitsch. f. Pfl. kr. **24**: 1–32. 1914.

mycelium is no doubt a constant corollary and necessity for all such short-cycle rusts that depend on a non-resting teliospore for propagation in temperate or arctic regions. It is probable that other species, now placed in the form genus *Aecidium* and considered unconnected aecial stages of heteroecious rusts, will prove to be short-cycle forms like *Endophyllum tuberculatum*. Suitable germination tests of such species will decide the matter.

PURDUE UNIVERSITY,
LAFAYETTE, INDIANA

Explanation of plate 1

ENDOPHYLLUM TUBERCULATUM (Ellis & Kellerm.) Arthur & Fromme

All figures drawn with the camera lucida at an approximate magnification of 625 diameters. FIG. 7 is from *Sidalcea candida*, all others from *Callirhoë involucrata*.

FIG. 1. A one-celled spore showing two nuclei.

FIG. 2. A two-celled spore.

FIG. 3. A peridial cell.

FIGS. 4, 5. Early germination stages of one-celled spores.

FIGS. 6–9. Later germination stages with septate promycelia producing basidiospores.

FIGS. 10–13. Promycelia the cells of which have produced germ tubes.

FIG. 14. A germinating two-celled spore; one of the cells has produced a promycelium.

Pollen development and degeneration in Zebrina pendula, with special reference to the chromosomes

ROBERT T. HANCE

(WITH PLATES 3–5)

The following work on the cultivated wandering Jew, *Zebrina pendula* Schniz., a plant which does not set seeds, was begun with the intention of studying any differences which might exist between the germinal and somatic chromosomes. So many interesting variations in the development of the pollen were found that the present paper is confined almost entirely to a description of these peculiarities.

The chief points developed in the following article are:

1. Parasynapsis occurs, which may readily be followed through the heterotypic divisions.

2. There is no fusion of chromosomes in the heterotypic division. The chromosomes appear in distinctly separated pairs. There are presumably one half as many pairs as there are somatic chromosomes and each pair behaves as a single chromosome—splitting transversely at division. Each daughter cell, therefore, receives as many *pairs* as the mother cell possessed though of one half the size.

3. The number of pairs varies from twelve to fifteen.

4. Chromosomes having the appearance, at first sight, of heterochromosomes appear, but further study shows that any chromosome may behave as such.

5. Entire chromosomes and fragments of chromosomes may be omitted from the reformed nucleus in either the heterotypic or homotypic divisions.

6. The pollen grains grow to a large size, the nucleus may or may not divide, and the cell then vacuolates and goes to pieces leaving only the outer coat shriveled and cracked.

7. Such somatic mitoses that have been observed show a long slender chromosome, whereas the germinal cells possess a short broad chromosome.

It gives me great pleasure to gratefully acknowledge the many valuable suggestions offered by Professor H. M. Benedict during the progress of my work.

MATERIAL AND METHODS

The cultivated wandering Jew was selected because of the ease with which it can be raised in the house and because it flowers steadily through the winter months.

Weak and strong Flemming's solution, equal parts of glacial acetic and absolute alcohol, and Gilson's killing agents were used and the strong solution of Flemming was found to be by far the most satisfactory. The material remained in the fixing fluid from six to twelve hours, and was washed in running water for a similar length of time.

As *Zebrina pendula* produces at various intervals from eight to twelve or more flowers at one point numerous stages may be found in a single piece of material.

Iron alum haematoxylin proved excellent but by far the best results were obtained with safranin counterstained with light green. The chromosomes are very large and when stained with safranin stand out with a sharpness that makes counting and drawing simple. The slides were allowed to remain from two and one half to three hours in safranin and from two to three seconds in light green followed by absolute alcohol, clove oil fifteen minutes, xylol three to four minutes and mounted in balsam or euparal. The latter was found to be excellent for the quickness with which it hardened and the clearness of the finished slide. Sections were cut 10 μ thick though 15 or 20 μ would be better owing to the size of the cells.

Most of the figures were drawn from the safranin preparations.

DEVELOPMENT AND DEGENERATION OF THE POLLEN

Heterotypic Division

Prophase.—The earliest stage observed is pictured in FIG. 1. The nucleus is composed of a dense network and two nucleoli stand out sharply. One is larger than the other and each is surrounded by a clear area. The growth period that ensues is figured in the next few drawings. In FIGS. 2 and 3 the cytoplasm has apparently grown away from the nucleus. This may be an

artefact, though it has been observed a number of times. In FIG. 2 the smaller nucleolus is seen to have lost a great deal of its staining capacity and is moving to the outer edge of the nucleus. It undoubtedly degenerates as only the one large nucleolus is found in succeeding stages.

As the spireme begins to form, the chromatin appears in long threads which completely fill the cavity shown in FIG. 3. The nucleolus stains less deeply but is still very distinct (FIG. 4).

FIGS. 4–7 show various steps in synapsis. FIG. 5 shows the cell developed to its maximum size. The chromatin threads of FIG. 4 have grown to form thick chromatin bands. No foundation has been found, after careful measurement of many different stages of synapsis, for the theory that synapsis is due to a growth of the cytoplasm away from the nucleus. The nucleolus is shown in FIGS. 6 and 7 (*N*). FIG. 7 shows the nucleolus beginning to vacuolate, a process which always seems to precede its disappearance.

As the chromatin bands come out of synapsis it is plainly evident that they are paired—FIG. 8. In FIG. 9, in which the paired bands are already splitting transversely to form the chromosomes, the paired nature is still more plainly visible.

Metaphase.—In the polar views of the metaphase of the pollen mother cells the chromosomes always appear in pairs. In counting great care was taken to secure uncut cells. In a few cases certain single chromosomes were counted as a pair when no other chromosome could be found near it which might be considered its mate. It was believed that its mate was probably covered by itself. With this method of counting FIG. 10 shows thirteen pairs of chromosomes, FIG. 11, thirteen pairs, FIGS. 12 and 13, twelve pairs each. FIG. 18, which, if we judge from the size of the chromosomes and their position, is the early anaphase of the heterotypic division shows fourteen pairs of chromosomes and FIG. 14, which is a similar stage, has fifteen pairs.

In FIG. 15 the two chromosomes "*X*" have all the appearances of heterochromosomes, but FIGS. 16 and 17 show that any chromosome or chromosomes may behave in a peculiar way. In FIG. 16 we find an "odd" body (*X* and *Y*) going to each pole ahead of the other chromosomes while FIG. 17 shows a pair trailing after the

others. It is safe then, I think, to conclude that no odd chromosomes occur in *Zebrina pendula* and that any chromosome may act in a manner not unlike that of the well-known accessory chromosomes.

Anaphase.—Judging from the size and position (i. e., at one end of the cell) of the chromosomes, FIGS. 14, 18, and 19 are anaphases. The paired arrangement of the chromosomes is still apparent and it is evident that the pairs are just one half the size of those in the mother cells. They have resulted from a transverse division of the chromosome pairs and in FIG. 10 the early indication of a transverse split is shown at *A* and *B*. Owing to the size of the cells it is practically impossible to find an uncut cell showing both ends of the anaphase in the same section, but FIG. 20 is a drawing carefully built up from two sections. The dark dotted line in the figure merely indicates the line of separation between the two groups of chromosomes and does not appear on the slide. 27 chromosomes appear at each pole and though the paired arrangement is not so apparent as in the preceding figures, it can still be seen in a few cases.

The dividing wall formed after the heterotypic division is pictured in FIGS. 21–23. In the first two drawings chromatic fragments are figured which trail after the other chromosomes and which probably will fail to reach the reforming nucleus in time to be included. Two entire chromosomes have been omitted from the nucleus in FIG. 23.

Homotypic Division

No dividing cells of this stage which permitted a count of the chromosomes have been found. The period of rest between the heterotypic and homotypic divisions is not very long. As in the case of the previous division, chromosomes may fail to reach the nuclei of the tetrads as shown in FIG. 25. FIG. 26 is a drawing of a complete tetrad.

The Pollen Cell

Each member of the tetrad undergoes enormous growth resulting in the pollen grains pictured in FIGS. 29 and 30. The nucleus may divide once but no later stage has ever been observed.

The cytoplasm becomes vacuolated and finally disappears entirely, leaving the cracked and shriveled outer coat, FIG. 27. Many anthers have been found filled with these empty coats.

SOMATIC MITOSIS

A single drawing of the typical somatic mitosis has been included with the others, FIG. 28. It can readily be seen that the chromosomes are strikingly different from those figured in the other drawings.

DISCUSSION

The above work is of interest in comparing the development of the pollen in normal seed producing plants with that of a plant that has lost its power of setting seeds. It is impossible to say at present whether or not the non-production of seeds is due to the irregularities appearing in the chromosome behavior. Farmer and Shove (**2**) consider that the varying number of chromosomes in *Tradescantia virginica* may be due "possibly to the common failure of the plant to set seeds." They, too, have recorded cases of chromatic fragments and chromosomes being omitted from the reformed nucleus and claim that they degenerate and are lost in the cytoplasm.

The question of synapsis will not be discussed here for, although I am inclined to the view of parasynapsis from the stages observed, the evidence is not sufficient as yet to base definite conclusions on. Overton (**9**) gives an excellent bibliography covering this question and the general field of cytology. In *Tradescantia* and *Galtonia*, Mottier (**8**) holds that "there is in many cells a marked tendency for some of the segments to adhere end-to-end, forming chain-like rows of sausage or kidney-shaped pieces." The peculiar conditions, however, existing in synapsis and reduction in the heterotypic divisions of *Zebrina pendula* suggest once more the question raised by Atkinson (**1**) as to whether, among plants, there "are not different types of chromosome reduction."

The lack of fusion between the individuals of the chromosome pairs in the heterotypic division may point to a hybrid origin. Gates (**3**) has cited conditions somewhat similar in hybrid *Oeno-*

theras which were sterile and has reviewed a number of other cases (4). The two germ plasms of Guyer's hybrid pigeons were found to remain separate in the cells of the testes. Speaking of a large chromosome appearing on the spindle as four small rings or vesicles, he says: "It is possible that this indicates a demarcation into tetrads, visible in hybrid material because of the firmer fusion which occurs normally at this stage is lacking. . . . It simply means, that in all probability there is an incompatibility between the chromosomes from the two different species which, in some cases, prevents them from uniting for the pseudo-reduction that normally occurs at this time." He also finds that "the division may be such that a portion of the chromatin is cut out entirely and is left behind in the cytoplasm." (5.)

Miyaki (6) states that the reduced number of chromosomes in *T. virginica* is twelve while Farmer and Shove claim the number to vary between twelve and sixteen. In the present study the number has been found to range between twelve and fifteen.

Mottier (7) states that the chromosomes of *Tradescantia virginica* are arranged in pairs and that in the first division they may be attached end to end so that as they are drawn apart rings may be formed. Each half that goes to the poles soon appears to be paired and remains in that condition until the second division, when the members of the pair separate. This differs from the case reported in the present article in that the pairs in *Zebrina pendula* behave as single chromosomes right through the first division and no evidence of a second longitudinal division has been observed.

The great difference between somatic and germinal chromosomes would seem to point to the fact that chromosomes are influenced by the chemistry of the cell. The writer has observed a difference in the chromosome number of the somatic and germ cells of the pig and in another paper has discussed the importance of chromosomes in heredity from this point of view.

BOTANICAL LABORATORY,
UNIVERSITY OF CINCINNATI

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Explanation of plates 3–5

The drawings were made at table level with the aid of a Leitz camera lucida and using a Zeiss 2 mm. apochromatic objective and a No. 12 ocular. FIG. 27 is the one exception, being drawn under a 3 mm. objective and a No. 6 ocular. Drawn to the same scale as the other figures it would be about as large as FIGS. 29 and 30. The drawings are reduced one third.

SYMBOLS. *N*, large nucleolus. *X* and *Y*, "odd" chromosomes. *n*, small nucleolus. *A* and *B*, chromosomes showing preliminary split.

FIGS. 1–9. *Prophase of Heterotypic Division*

FIG. 1. Two nucleoli appear staining equally.

FIG. 2. Cytoplasm has grown away from nucleus. Smaller nucleolus has lost some of its staining capacity and has moved to one edge of the nucleus.

FIG. 3. Smaller nucleolus has been cast out of nucleus.

FIG. 4. Nucleus has spread to fill the cavity shown in FIG. 3. Chromatin network is beginning to form. Only one nucleolus is present.

FIG. 5. Beginning of synapsis.

FIG. 6. Later stage of synapsis showing nucleolus.

FIG. 7. Later stage of synapsis showing nucleolus beginning to vacuolate.

FIG. 8. The chromatin mass has opened up preparatory to dividing into chromosomes. The parallel arrangement of chromatin bands is apparent.

FIG. 9. Chromatin bands constricting to form the individual pairs of chromosomes. The paired arrangement is marked.

FIGS. 10–17. *Metaphase of Heterotypic Division*

FIG. 10. Polar view showing 13 pairs of chromosomes.

FIG. 11. Polar view showing 13 pairs of chromosomes.

FIG. 12. Polar view showing 12 pairs of chromosomes.

FIG. 13. Polar view showing 12 pairs of chromosomes.

FIG. 15. Side view of spindle showing what are apparently "odd" chromosomes (*X*).

FIG. 16. Same as 15 showing an odd body going to each pole (*X* and *Y*).

FIG. 17. Early anaphase showing a pair of chromosomes trailing after the others.

FIGS. 14–23. *Anaphase of Heterotypic Division*

FIG. 14. 15 pairs of chromosomes appear.

FIG. 18. 14 pairs of chromosomes appear.

FIG. 19. 13 pairs of chromosomes appear.

FIG. 20. A drawing built up from two sections. 27 individual chromosomes can be counted as the pairing is not so obvious. The dotted line does not appear on the slide.

FIGS. 21, 22, 23. Division completed showing reformed nuclei with chromatic fragments and whole chromosomes omitted.

FIGS. 24–26. *Homotypic Divisions*

FIGS. 24, 25, 26. Stages in the formation of tetrad. FIG. 25 shows a chromosome omitted from the reformed nucleus.

FIGS. 27–30. *Miscellaneous*

FIG. 27. Shows the empty and broken pollen covering.

FIG. 28. Somatic mitosis, drawn from a dividing cell in a young sepal.

FIG. 29. Mature pollen, a single nucleus appears and the cell is beginning to vacuolate.

FIG. 30. Mature pollen. Two nuclei are shown.

Mosses of Bermuda

ELIZABETH G. BRITTON

(WITH PLATES 6 AND 7)

There has been no list of the mosses of Bermuda published since 1885,* when William Mitten studied the collections made by the Challenger Expedition and enumerated five genera and eight species, of which two were described as new. One of these, *Trichostomum bermudanum* Mitt., has proved to be endemic and two others, *Tortula melanocarpa* Mitt. and *Isopterygium tenerum* Mitt., have been referred to older names. No localities were recorded.

A taxonomic study of the flora of Bermuda was undertaken by the New York Botanical Garden in 1905† in cooperation with the Academy of Natural Sciences of Philadelphia, and several visits have been made by Mr. Stewardson Brown and Dr. and Mrs. N. L. Britton at various times of the year in pursuit of this investigation. These have yielded twenty genera and twenty-eight species of mosses and added another endemic species, *Campylopus bermudianus*. It will thus be seen that the island is not rich in mosses and the most widely distributed species is *Trichostomum bermudanum* which occurs rather commonly on stone walls and limestone rocks, particularly in shady moist places. A few of the rarer species are likely to become extinct with the clearing, burning and cultivation of the marshes, notably the species of *Sphagnum*, *Campylopus*, *Syrrhopodon* and *Isopterygium;* a few others are only to be found in a few deep dark crevices and caves in the parish of Hamilton. Besides the two endemic species, there are eight cosmopolitan ones belonging to the five genera *Bryum*, *Eucladium*, *Funaria*, *Hymenostylium*, and

* Voyage of H. M. S. Challenger, pp. 89–92. 1885.

† Bermuda in September, Jour. N. Y. Bot Gard. **6**: 153–158. 1905; Botanical Exploration in Bermuda, Jour. N. Y. Bot. Gard. **13**: 189–194. 1912; Gardens of Bermuda, Jour. N. Y. Bot. Gard. **14**: 172. 1913; Jour. N. Y. Bot. Gard. **15**: 148. 1914.

Weisia; six having a wide range in temperate North America, Europe and Asia, belonging to the genera *Amblystegium*, *Anomodon*, *Isopterygium*, *Leucobryum*, and *Sphagnum;* and ten species of subtropical or tropical distribution: most of these are not known to occur except in America and represent the eight genera *Cyclodictyon*, *Fissidens*, *Gyroweisia*, *Rhacopilum*, *Sematophyllum*, *Syrrhopodon*, *Thuidium*, and *Tortula*.

Dr. Evans has listed* twenty genera and twenty-two species of the Hepaticae and has since reported two species of *Anthoceros*,† thus bringing the total number of bryophytes to forty-one genera and fifty-two species, the number being almost equally divided between hepatics and mosses. None of the Hepaticae are endemic.

In the following enumeration, unless otherwise stated, the specimens cited by number were collected by Mr. Stewardson Brown or Dr. and Mrs. N. L. Britton; a few were collected by Dr. M. A. Howe in July, 1900.

1. SPHAGNUM MAGELLANICUM Brid.

Sphagnum medium Limpr. Not *Sphagnum cymbifolium* Ehrh., as listed by the Challenger Expedition.

Devonshire Marsh, *M. A. Howe.*

2. SPHAGNUM CUSPIDATUM SERRATUM Schliep.

Sphagnum trinitense C. Müll.

Devonshire Marsh, *M. A. Howe;* Pembroke Marsh, *340*, *417*.

3. CAMPYLOPUS BERMUDIANUS R. S. Williams.

On damp ground in shade of palmetto, Paget Marsh, *651*, *1138*, *1872*.

4. LEUCOBRYUM GLAUCUM (L.) Schimp.

Devonshire Marsh, *M. A. Howe 376;* Paget Marsh, on the ground under shade of palmetto, *1860*.

5. FISSIDENS GARBERI Lesq. & James.

On rocks near Harrington House, *548a;* gully, Abbot's Cliff, *893*, *951*, *1859*.

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* Bull. Torrey Club **33**: 129–135. *pl. 6.* 1906.

† Brylogist **13**: 36. 1910; **16**: 55. 1913.

6. FISSIDENS MINUTULUS Sull.

Calcareous rocks, gully near Tuckerstown, *322;* on stones in shade, Church Cave; also on Abbot's Cliff, mixed with *893* and *951*.

7. FISSIDENS TAXIFOLIUS (L.) Hedw.

On the ground in woods near Walsingham Caves, *M. A. Howe*, also *284*.

8. SYRRHOPODON FLORIDANUS Sull. (PLATE 6.)

On base of palmetto in dense mats, sterile; propagating by gemmae from the tips of the leaves. Devonshire Marsh, *M.A. Howe;* Paget Marsh *233*, *655*, *656*, *1856*.

9. WEISIA VIRIDULA (L.) Hedw.

Castle Harbor, Walsingham, *430a*.

10. WEISIA LONGISETA Lesq. & James.

Near Harrington House, *432;* on rocks, Walsingham, *485;* near Tuckerstown, *501*.

11. GYROWEISIA BARBULA (Schwaegr.) Par.

Tortula melanocarpa Mitt. (Challenger Report.)

On rocks near Tuckerstown, *502;* roadside rocks near Paynter's Vale, *517;* also near Harrington House, *549*.

12. EUCLADIUM VERTICILLATUM (L.) Br. & Sch.

Tortula verticillata Mitt. (Challenger Report.)

Wet limestone rocks, Smuggler's Cave, *M. A. Howe;* Church Cave, *271;* walls of Cooper's Hole, Paynter's Vale.

13. HYMENOSTYLIUM CURVIROSTRE (Ehrh.) Lindb.

Under dripping limestone rocks forming calcareous tufa, Church Cave; Walsingham Cave, *1193*.

14. TRICHOSTOMUM BERMUDANUM Mitt.

"In extensive patches on calcareous sand" without locality, Challenger Expedition; on stone wall, Hamilton, *M. A. Howe;* rocks, north shore, *62;* Devonshire Marsh, *97;* rocks and stone walls near Harrington House, *442a*, *833;* Paget Sand Hills, *620;* on the ground, Paynter's Vale, *805*, *808;* Hall's Island, Harrington Sound, *894;* Abbot's Cliff, *926;* St. David's Island, *1064*, *2082;* Montrose, *2214*.

15. TORTULA AGRARIA (Sw.) Sw.

On calcareous rocks near Paynter's Vale, *466;* also near Harrington House, *548*.

16. FUNARIA HYGROMETRICA (L.) Sibth.

On rocks near Harrington House, *551*.

17. FUNARIA FLAVICANS Michx.

Without definite station, *Mrs. W. E. Damon*, 1888.

18. BRYUM DICHOTOMUM Hedw.

Without definite station, Challenger Expedition.

19. BRYUM CAPILLARE L.

Fruiting plants were collected on rocks near Paynter's Vale, *465;* sterile specimens, propagating by gemmae, were found in Paget Marsh, *227;* gully in Abbot's Cliff, *928;* on the side of a cistern, the Flats, *A. B. Hervey*, 1913.

20. BRYUM CRUEGERI Hampe.

Sterile specimens, on stones, Devonshire Marsh, *160*.

21. CYCLODICTYON VARIANS (Sull.) Broth.

On damp rocks in shade, Walsingham Cave, *283;* Church Cave, *801, 1089*.

22. RHACOPILUM TOMENTOSUM (Sw.) Brid. (PLATE 7.)

Without definite station, Challenger Expedition; shaded rocks, fruiting, gully and cave, Paynter's Vale, *326;* Church Cave, *503, 507, 510, 1091;* Gully near Tuckerstown, *515;* Abbot's Cliff, *892, 1857*.

23. ANOMODON ROSTRATUS (Hedw.) Schimp.

A lax sterile form of this species has been found on shaded rocks at a cave near Harrington House, *558*, at Paynter's Vale, *806*, and on Abbot's Cliff, *1877*.

24. HAPLOCLADIUM MICROPHYLLUM (Sw.) Broth.

On shaded rocks, Abbot's Cliff, *890, 925, 926;* Church Cave, *1092*.

25. THUIDIUM MINUTULUM (Hedw.) Br. & Sch.

In gully, Paynter's Vale, *361*.

26. AMBLYSTEGIUM VARIUM (Hedw.) Lindb.

Damp rocks, Church Cave, fruiting, *509*, *804*, *1093;* shaded rocks, Paynter's Vale, *806* in part.

27. ISOPTERYGIUM MICANS (Sw.) Mitt.

Isopterygium tenerum Mitt. (Challenger Report.)

On root-stocks of *Osmunda cinnamomea*, and on old stumps, Devonshire Marsh, *44*, *568*, *809*, *812;* at base of palmetto, Paget Marsh, *647*, *1855;* Pembroke Marsh, *626;* Warwick Marsh, *623*.

28. SEMATOPHYLLUM ADNATUM (Michx.) E. G. Britton.

On cedar tree, Walsingham Cave, *282;* on rotten wood, near cave, Paynter's Vale, *1117*.

Explanation of plates 6, 7

PLATE 6. SYRRHOPODON FLORIDANUS Sull.

Drawings made with a magnification twice the diameter reproduced on the plate.

FIG. 1. Plant, natural size.

FIG. 2. Plant enlarged.

FIG. 3. Cross section of stem, ×120.

FIGS. 4–7. Leaves, ×18½.

FIG. 8. A portion of base of leaf showing curve, ×87½.

FIG. 9. Apex of leaf showing end of costa, ×120.

FIG. 10. The large hyaline cells of basilar portion of leaf, ×500.

FIG. 11. Cells of the basilar and median portions of leaf taken from the upper edge of the hyaline group, represented in Figs. 4, 5, and 7, by dotted lines, ×500.

FIG. 12. Marginal cells, ×500.

FIGS. 13, 14. Median cells, ×500.

FIG. 15, Portion of ventral surface of leaf from costa to margin, ×210.

FIG. 16. Surface view of double margin from median portion of leaf, ×120.

FIGS. 17, 18, 19. Cross sections of double margin, 17, 18, ×270; 19 ×210.

FIG. 20. Surface view of lower portion of costa, ×120.

FIG. 21. Surface view of upper portion of costa showing papillae, ×120.

FIG. 22. Cross section of lower portion of leaf, ×120.

FIG. 23. Portion of same with higher magnification, ×210.

FIG. 24. Cross section of upper portion of leaf, ×210.

FIGS. 25, 26. Cross sections of costa showing papillae on costa and the cells of the upper portion of leaf, ×210.

FIG. 27. Apex of leaf with gemmae and filaments arising from both the dorsal and ventral surface of costa tip, ×87½.

FIG. 28. Filaments arising from cells of the costa in median portion, ×120.

FIG. 29. Filament arising from a cell of the basilar portion of costa, ×87½.

FIG. 30. Filaments arising from median cells near double margin, ×87½.

FIG. 31. Gemma arising from a median cell, ×87½.

FIGS. 32–34. Gemmae, ×87½.

PLATE 7. RHACOPILUM TOMENTOSUM (SW.) Brid.

The figures were drawn with a magnification three times greater than that indicated and the resulting figures were reduced to one third.

FIG. 1. Plant, natural size.
FIG. 2. Branch showing arrangement of large and small leaves, ×6⅔.
FIG. 3. Large leaf, ×12⅓.
FIG. 4. Small leaf, ×12⅓.
FIG. 5. Apex of large leaf showing excurrent costa, ×80.
FIG. 6. Basal cells of large leaf, ×80.
FIG. 7. Median cells of large leaf, ×195.
FIG. 8. Surface view showing papillae, ×333⅓.
FIG. 9. Cross section of leaf, ×138⅓.
FIG. 10. Cross section of stem, ×80.
FIG. 11. Perichaetial bud, ×19⅔.
FIG. 12. Capsule, ×4⅔.
FIG. 13. Portion of capsule with lid and calyptra, ×10.
FIG. 14. Peristome, ×80.
FIG. 15. Annulus, ×80.
FIG. 16. Spores, ×80.

A new Hawaiian Cyanea

JOSEPH F. ROCK

(WITH PLATE 8)

The genus *Cyanea* belongs to the family Campanulaceae, subfamily Lobelioideae, and is endemic to the Hawaiian Islands. It contains more species than any other Hawaiian genus of this subfamily, most of the species being arborescent. On the island of Kauai the species are few in number but decidedly distinct. On the islands of Maui and Molokai they are more numerous but also more variable, certain of the species apparently merging into one another. The species described below is named for Mr. G. K. Larrison, superintendent of hydrography.

Cyanea Larrisonii sp. nov.

Stem fleshy, apparently not branching, foliose at the apex, puberulous: leaves linear-lanceolate, acuminate at both ends, minutely mucronate, pale whitish underneath, light green above, glabrous on both surfaces, midrib and veins prominent below, chartaceous, 20–23 cm. long (including a puberulous petiole of 15–18 mm.), 12–20 mm. wide, entire or minutely denticulate in the upper third: raceme 1 cm. long, four- to six-flowered, bibracteate at the middle; bracts 12 mm. × 1 mm.; pedicels 5–6 mm. long; calyx subglobose, dark purplish-black, 5 mm., minutely toothed, tomentulose; corolla slender, 3 cm. long, 3.5–4 mm. wide, dark bluish-black, slightly curved, the dorsal slit extending beyond the middle, tomentose, especially near the apex; staminal column dark purple, glabrous, with a patch of purplish hairs at the base, anthers glabrous, pale, with purplish streaks, the two lower only tufted at the apex; stigma minutely two-lobed, scarcely protruding: berry (immature) globose, purplish-black.

KAUAI: Upper Hanalei Valley, on ridge between Hanalei and Kalihinui, elevation 1,800 feet, October 17, 1914, *G. K. Larrison 10342*. The type specimen is deposited in the College of Hawaii Herbarium.

A very striking species, somewhat related to *Cyanea recta*

Wawra, but differing from it in the linear-lanceolate leaves, which remind one of the leaves of *Rollandia parvifolia* Forbes; the very narrow corolla is almost straight and nearly black.

COLLEGE OF HAWAII,
HONOLULU, HAWAII

Explanation of plate 8

CYANEA LARRISONII Rock

FIG. 1. Part of plant, × 0.6.
FIG. 2. Flower, × 1.4.
FIG. 3. Longitudinal section of flower, × 1.4.

The North American species of Psilogramme*

William R. Maxon

In describing not long ago a new and peculiar species of *Psilogramme* from Porto Rico, it became apparent that the other North American members of the genus (mainly Costa Rican), though treated recently,† were not well understood. Still more recently an apparently undescribed species has been received from Chiapas, extending widely the known continental range of the genus. This has led to a further examination of the entire genus, with particular regard to the North American species. Some of the notes taken are given under the following provisional list of species now reported from North America. The sequence is essentially that of Kuhn's classification.‡

Key to the Species

Veins extending to the emarginate apex of the ultimate divisions.
- Fronds erect, obviously determinate; laminae narrow, the primary rachis straight or subflexuous; primary pinnae short, 3 to 8 cm. long.
  - Rhizome very slender (1 to 2.5 mm. thick), wide-creeping, the fronds 1 to 2.5 cm. apart..... 1. *P. Warscewiczii.*
  - Rhizome thick, ascending or decumbent, the fronds fasciculate.
    - Lamina pale yellowish or grayish green, densely spreading-villose throughout; pinnae rigidly herbaceous, crowded..... 2. *P. congesta.*
    - Lamina bright green, laxly glandular-hirsute; pinnae membrano-chartaceous, distant or subdistant..... 3. *P. chiapensis.*

Fronds very much larger, scandent or recumbent, tardily determinate; lamina ample, the primary rachis widely sinuose-flexuose or strongly divaricate-flexuose; primary pinnae greatly elongate, mostly 12 to 25 cm. long.
- Secondary pinnae all very sharply retrorse in attachment but at once curved upward, glabrous throughout; ultimate divisions 1.5 to 2 mm. broad..... 4. *P. glaberrima.*
- Secondary pinnae retrorse only at a broad angle or spread-

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† Christ in Bull. Herb. Boiss. II. 4: 1096–1099. 1904.

‡ Gruppe Chaetop. 13–22. 1882.

ing, not recurved, variously pubescent; ultimate lobes 1 mm. broad, or mostly much less.
Leaf tissue copiously short-villose upon both surfaces. 5. *P. villosula.*
Leaf tissue scantily pubescent.
Segments minute, the ultimate fertile lobes mostly about 1 mm. long, less than 1 mm. broad, sparsely and laxly pubescent upon both surfaces, or hairs more numerous among the sporangia... 6. *P. haematodes.*
Segments larger, the lobes longer and broader, widely divaricate, glabrous above, bearing a few short hairs beneath among the sporangia... 7. *P. refracta.*
Veins not attaining the margin; teeth of the ultimate segments not emarginate..... 8. *P. portoricensis.*

1. PSILOGRAMME WARSCEWICZII (Mett.) Kuhn, Gruppe Chaetop. 17. 1882.

Gymnogramma Warscewiczii Mett. Ann. Sci. Nat. Bot. V. 2: 211. 1864.

TYPE LOCALITY: Cartago, Costa Rica (*Warscewicz.*).

DISTRIBUTION: Costa Rica and Colombia, ascending to 3,000 meters.

ILLUSTRATION: Karsten, Fl. Columb. 2: *pl. 188, f. 3* (as *G. Warscewiczii*).

Psilogramme Warscewiczii was described by Mettenuis upon two collections, one from the Páramo San Fortunato, Colombia, altitude 2,800 meters (*Lindig 299*), the other from Cartago, Costa Rica (*Warscewicz*); the latter must be regarded as the type. The original description, which is very complete, points unmistakably to the common Costa Rican plant redescribed by Christ erroneously as *Gymnogramme hirta* Desv. It is true that *P. hirta* and *P. Warscewiczii* are similar in stature and cut of frond. The former species, however, has the numerous fronds closely fasciculate upon a very short rhizome, and the lamina conspicuously hispid or hirsute with stiff spreading hairs; whereas in *P. Warscewiczii* the fronds are borne singly, an inch or more apart, upon a slender, very widely creeping rhizome, and the lamina is inconspicuously short-villous along the rachises and veins, with lax appressed hairs. The stout stipes and generally sturdy appearance of *P. Warscewiczii* are equally characteristic. Karsten's figure, above cited, agrees well with Costa Rican material and differs only in representing a plant slightly above the maximum of the following specimens examined.

COSTA RICA: Volcán de Poás, altitude 2,300 to 2,644 meters, *J. D. Smith 6930* (3 sheets); *Tonduz 10712; Alfaro 121.* Volcán de Turrialba, alt. 3,000 meters, *Pittier 13256* (*J. D. Smith 7488*).

2. **Psilogramme congesta** (Christ) Maxon.

Gymnogramma congesta Christ, Bull. Herb. Boiss. II. 4: 1098. 1904.

TYPE LOCALITY: Forests of La Palma, Costa Rica, altitude 1459 meters (*Tonduz*).

DISTRIBUTION: Costa Rica, at altitudes of 1,300 to 1,500 meters.

This species has been very well described by Christ. It has the short rhizome, closely fasciculate fronds, and conspicuous spreading hispid covering of true *P. hirta*, but the rigidly erect fronds and sturdy appearance of *P. Warscewiczii*, a species which otherwise it does not closely resemble. The almost grayish, strongly hispid aspect of the plant has been mentioned by Christ. This feature, the close-set pinnae and pinnules of all the fronds, and the peculiarly strict and narrow appearance of the segments of the sterile fronds are the best distinctive marks of this excellent species.

COSTA RICA: Forêts de La Palma, alt. 1,300 to 1,459 meters, *Tonduz 12575; Brade.* La Hondura, near La Palma, alt. 1,500 meters, *Jimenez 594; Werckle 16683.* Without locality, *Werckle* (ex herb. Christ).

3. **Psilogramme chiapensis** Maxon, sp. nov.

Rhizome apparently short, decumbent, freely radicose beneath and at the sides, bearing at the apex numerous dark reddish brown, opaque, rigidly acicular, simple hairs, these 1.2 to 1.8 mm. long, consisting of 10 to 16 cells above the enlarged multicellular base; fronds about 6, fasciculate, 40 to 57 cm. long, erect-arching; stipe 20 to 25 cm. long, 1.3 to 2 mm. in diameter, dark brown from a purplish brown base, lustrous beneath a sparse subpersistent covering of lax multicellular simple brownish hairs; lamina linear-oblong or linear-deltoid to lanceolate, acuminate, 22 to 34 cm. long, 8 to 11 cm. broad, bipinnate-tripinnatisect, the primary rachis similar to the stipe, lightly angled, subflexuous in the apical half; larger primary pinnae about 10 pairs, slightly ascending, the lowermost 2 to 4 pairs opposite or nearly so, these the largest, 5 to 8 cm. long, 2 to 3.5 cm. broad, inequilateral, narrowly deltoid

or triangular-oblong, subacute, subfalcate, fully pinnate in the basal part, the subflexuous secondary rachis elsewhere narrowly foliaceo-marginate, densely clothed with spreading multicellular hairs, these with a darkish terminal gland; pinnules 6 to 10 pairs below the short, cleft or parted apex, mostly spreading, the basal pair slightly the largest or the 3 or 4 basal pairs subequal, regularly pinnatisect to the foliaceous costa, laxly hirsute upon both surfaces, more copiously so beneath, the hairs mostly gland-tipped; segments 2 or 3 pairs below the obtuse usually tripartite apex, mostly oblique, the larger ones inequilateral, obovate or trapeziform from a narrowly cuneate base, obliquely cleft into 2 or 3 lobes, these mostly bilobate at their tips; smaller segments narrower, cuneiform, strongly decurrent, only 2 or 3-lobed; veins very slender, dark brown above, subdichotomous, the 2 to 8 ultimate branches of each segment terminating at the faintly emarginate apices of the lobes; sporangia very numerous, falling short of the tips of the lobes but extending nearly to the base of the segments, the lines widely confluent at maturity. Leaf tissue yellowish green, delicately membrano-chartaceous.

Type in the U. S. National Herbarium, no. 464844, collected upon the Cerro del Boqueron, Chiapas, Mexico, September, 1913, by Dr. C. A. Purpus (*no. 6722*). A second and excellent sheet of three fronds of the same number is at hand; also a later collection from Chiapas (*Purpus 7219*).

Related to *P. hirta* and *P. glandulosa* of South America; differing from the former in its narrower, fewer-veined segments and its scantier, obviously glandular pubescence; and from the latter very conspicuously in the much greater size and subdivision of the lamina.

4. **Psilogramme glaberrima** Maxon, sp. nov.

A weakly scandent or recumbent plant, the elongate fronds lax, probably of tardily determinate growth. Rhizome and stipe wanting in the material at hand; lamina apparently 1.5 to 2 meters long, 40 to 50 cm. broad, narrowly oblong, tripinnate-quadripinnatisect, the segments of the fourth order 1 to 3 times divaricately dichotomous; primary rachis slender (1 mm. thick), sinuous-flexuous, brownish castaneous, highly lustrous, perfectly glabrous; primary pinnae alternate (those of the same side about 12 cm. apart), slightly ascending at their point of origin but lax, apparently drooping, orbicular-deltoid, 20 to 25 cm. long, 15 to 20 cm. broad, the lustrous glabrous castaneous secondary rachis sharply flexuous; secondary pinnae 4 or 5 pairs, contiguous,

petiolate, all sharply retrorse in attachment but immediately curved upward, thus spreading or mostly ascending, the basal ones the largest, these deltoid-oblong, 9 to 11 cm. long, about 5 cm. broad, consisting of about 5 pairs of spreading, mostly inequilateral, obtuse, deltoid-oblong, deeply pinnatisect pinnules; tertiary rachises castaneous nearly throughout, narrowly foliaceo-marginate in the middle, or widely so toward the apex of the secondary pinnae; segments of the larger pinnules mostly once or twice dichotomous, the divisions divaricate, mostly simple, 2 to 5 mm. long, 1.5 to 2 mm. broad, slightly broader than the widely foliaceous rachises of the pinnules; veins solitary, evident, very slender, brownish, extending to a very narrow but deep sinus in the rounded apex of the lobe; sporangia dark brown, very numerous, those of two (rarely more) adjacent lobes joined at the base. Leaf tissue membrano-papyraceous, grayish green, fragile; hairs wholly lacking throughout, even among the sporangia.

Type in the U. S. National Herbarium, no. 827510, collected in the forests of La Palma, Costa Rica, altitude 1,459 meters, September 4, 1898, by A. Tonduz (*no. 12531*). Collected also at the same place by Brade (March 17, 1908) and by the writer (*no. 398*, May, 1906), these specimens smaller than the type collection but otherwise identical. A specimen collected by Wright at Omotepec, Nicaragua, while upon the North Pacific Exploring Expedition, is certainly the same.

Psilogramme glaberrima apparently lacks any very near relatives. In several respects it somewhat resembles *P. Orbignyana;* namely, in habit, in its flexuous secondary rachises, and in the position and curvature of its secondary pinnae, these arising retrorsely but being immediately curved and directed forward. The resemblance ends here, however, *P. Orbignyana* having numerous veinlets to the ultimate segments.

5. **Psilogramme villosula** Maxon, sp. nov.

Rhizome wanting; fronds suberect, apparently 40 to 60 cm. long; stipe incomplete, 2 to 2.5 mm. in diameter, woody, dark castaneous, sublustrous, glabrescent; lamina oblong, apparently 30 to 40 cm. long, 12 to 25 cm. broad, tripinnate or almost quadripinnate, the pinnules further divided; primary rachis similar to the stipe, subpersistently short-villose with a thin covering of short multicellular yellowish flattish hairs; primary pinnae alternate, arising at an angle of about 45°, then recurved, deltoid-oblong, acute, 8 to 15 cm. long, the secondary rachis subflexuous,

densely short-villose; secondary pinnae approximate or mostly apart, short-petiolate, deltoid-oblong, the basal ones reflexed, up to 4.5 cm. long, the others spreading; pinnules 4 or 5 pairs, spreading or slightly reflexed, rounded-triangular or narrowly subovate in outline, the larger ones cut to the narrowly marginate costa, with about 2 pairs of deeply cleft dichotomo-flabellate segments, the ultimate divisions 1 to 1.5 mm. long and about 1 mm. broad, their tips narrowly emarginate to the slender brownish vein; leaf tissue delicately herbaceous, together with the rachises and costae densely short-villose beneath, more sparsely so above, the hairs similar to those of the primary rachis or a little longer and stiffer; sporangia very numerous, usually borne throughout the veins of the segments and almost wholly covering the leaf surface, with numerous hairs intermixed.

Type in the U. S. National Herbarium, no. 471992, collected upon the Cerro de las Vueltas, Costa Rica, altitude 3,000 meters, January, 1897, by H. Pittier (*no. 10502*). A second sheet of this collection contains two laminae which are smaller but otherwise identical.

This, which is a very distinct species, is founded upon one of the two members cited by Christ* as representing *Gymnogramme Warscewiczii;* but it agrees not at all either with Mettenius's excellent description or with Karsten's later illustration. The second specimen cited by Christ (El Páramo, région du General, *Pittier 10452*) is probably still another species.

6. **Psilogramme haematodes** (Christ) Maxon.

Gymnogramma haematodes Christ, Bull. Herb. Boiss. II. 4: 1097. 1904.

TYPE LOCALITY: Summit of Volcán de Poás, Costa Rica, altitude 2,644 meters (*Tonduz 10713*).

DISTRIBUTION: Upper slopes and summits of the volcanoes Poás, Barba, Irazú, and Turrialba, Costa Rica, altitude 2,400 to 2,644 meters.

This species, well described by Christ, is exceedingly well marked by its minute, short, slightly pubescent, close-set ultimate segments. It can hardly be confused with any North American species, except possibly the plant here listed as *P. refracta.*

COSTA RICA: Summit of Volcán de Poás, alt. 2,644 meters,

* Bull. Herb. Boiss. II. 4: 1098. 1904.

Tonduz 10713. Volcán de Irazú, alt. 2,400 meters, *J. D. Smith 4999*. Forêts du Barba, *Pittier 1936*. Volcán de Turrialba, alt. 2,500 meters, *Alfaro 52*.

7. **Psilogramme refracta** (Kunze) Maxon.

Gymnogramma refracta Kunze; Klotzsch, Linnaea **20**: 410. 1847.

Anogramma refracta Fée, Gen. Fil. 184. 1852.

TYPE LOCALITY: Sierra Nevada, Colombia (*Moritz 359*).

DISTRIBUTION: Colombia and Costa Rica, ascending to 2,300 meters.

ILLUSTRATION: Fée, op. cit. *pl. 19. A. f. 2* (as *A. refracta*).

The present species is here determined solely from the original description and the small detailed figures by Fée. Without an examination of the Moritz type specimen it cannot be shown positively that Kuhn erred in referring this form to *P. flexuosa*, yet from the data at hand this seems almost certain. In any event, the Costa Rican plant mentioned below is not referable to *P. flexuosa*. Of published species it seems to agree only with the South American *P. refracta;* and if it is not really of that species it must subsequently be described as new. Its distinctive characters are indicated in the key.

COSTA RICA: Volcán de Poás, province of Alajuela, alt. 2,300 meters, March, 1896, *J. D. Smith 6931* (3 sheets).

8. PSILOGRAMME PORTORICENSIS Maxon, Contr. U. S. Nat. Herb. **17**: 412. 1914.

TYPE LOCALITY: Extreme summit of El Yunque, Porto Rico, altitude 1,110 meters.

DISTRIBUTION: Known only from the type collection (*Hioram 348*).

ILLUSTRATION: Contr. U. S. Nat. Herb. **17**: *pl. 15*.

One of the smallest species of the genus, and the only North American member of the group in which the veinlets do not extend to emarginate apices of the teeth. It has previously been compared with *P. hispidula* (Klotzsch) Kuhn, which is probably its nearest relative.

EXCLUDED OR DOUBTFUL SPECIES

PSILOGRAMME DOMINGENSIS (Baker) Underw. Bull. Torrey Club **29**: 628. 1902.

Gymnogramma domingensis Baker, Ann. Bot. **5**: 485. 1891.

TYPE LOCALITY: Alto Causal, Santo Domingo, altitude about 2,100 meters.

DISTRIBUTION: Known apparently only from the type collection.

It is impossible to determine from description whether this species, transferred to *Psilogramme* by Underwood, properly belongs to that genus. Not only is the description incomplete, but the rhizome is said to be wanting in the type specimen.

PSILOGRAMME SCHIZOPHYLLA (Baker) Underw. Bull. Torrey Club **29**: 629. 1902.

Gymnogramme schizophylla Baker, Jour. Bot. **15**: 266. 1877.

Anogramma schizophylla Diels in Engl. & Prantl, Pflanzenfam. **1**[4]: 258. 1899.

TYPE LOCALITY: Old England, Jamaica (*Miss Taylor*).

DISTRIBUTION: Several localities in the Blue Mountains, Jamaica, altitude 1,200 to 1,500 meters; reported also from Cuba.

ILLUSTRATION: Hook. Icon. Pl. *pl. 1682* (as *Gymnogramme schizophylla*).

This is a peculiar species whose proper disposition is doubtful. From its broad deltoid scales it is assuredly no member of *Psilogramme*, and its reference to *Anogramma* by Diels is scarcely more satisfactory. Of recognized genera it is nearest to *Pityrogramma* (*Ceropteris*) and may perhaps belong to that.

INDEX TO AMERICAN BOTANICAL LITERATURE
1910–1915

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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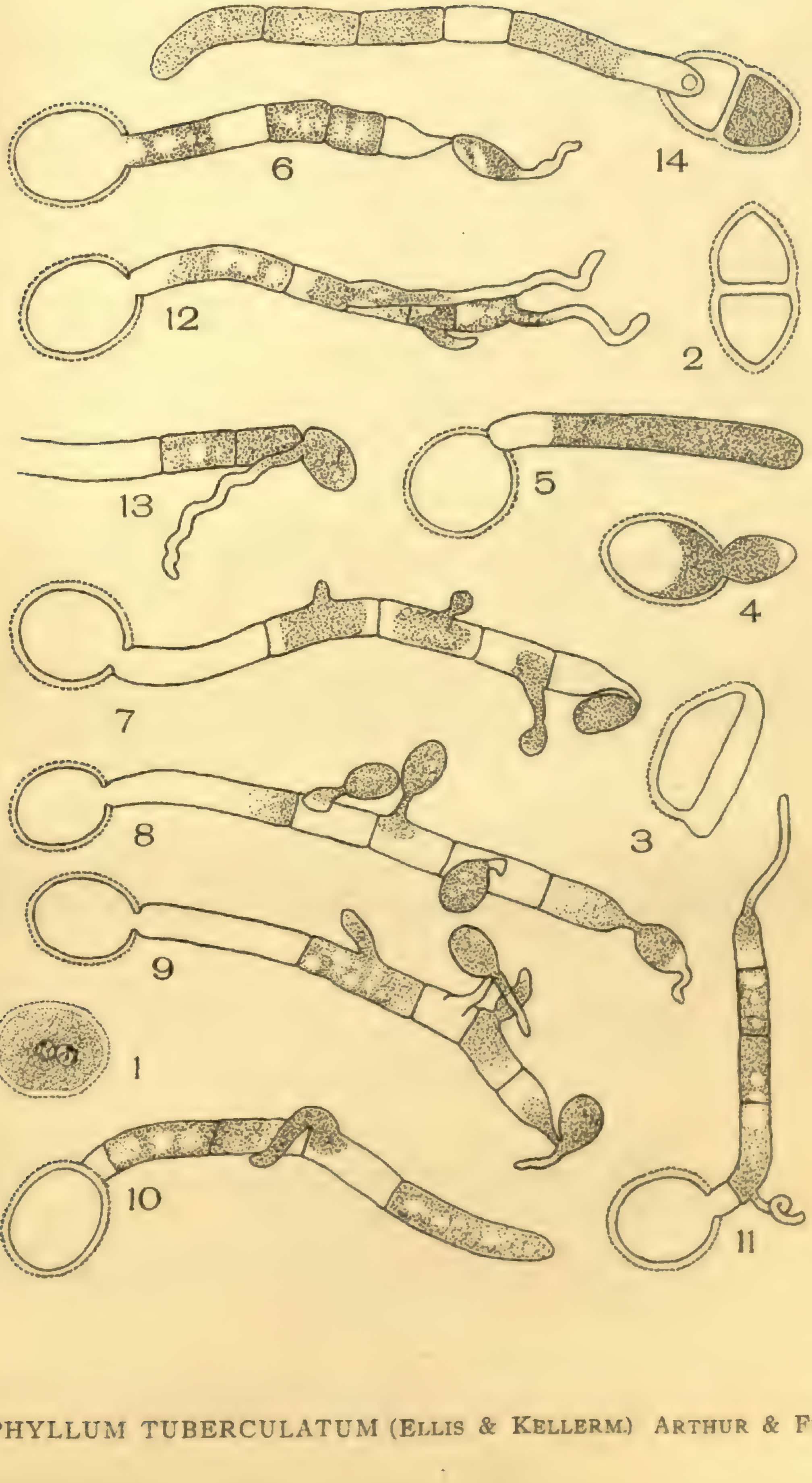

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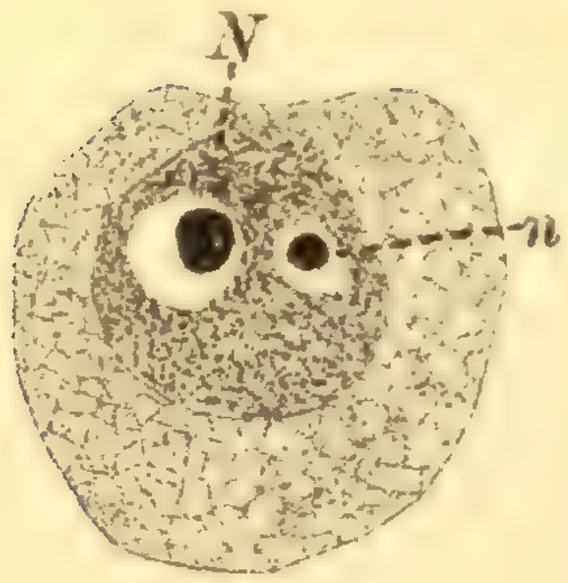

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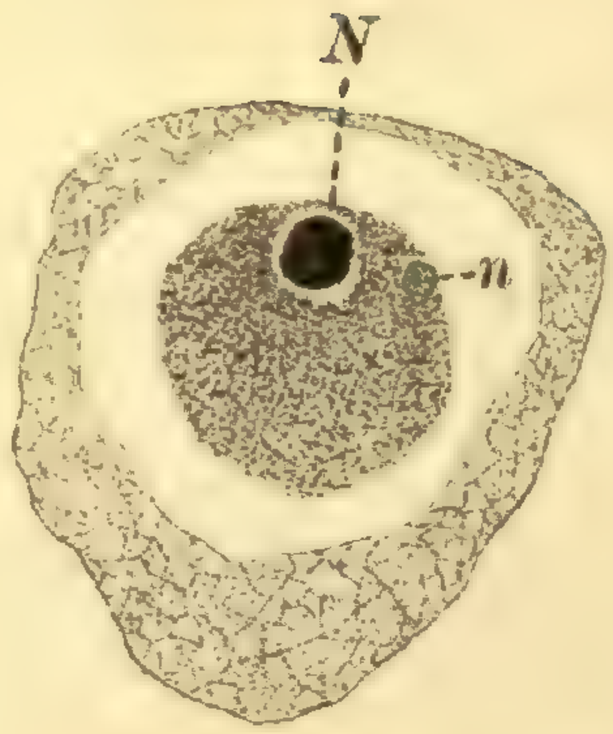

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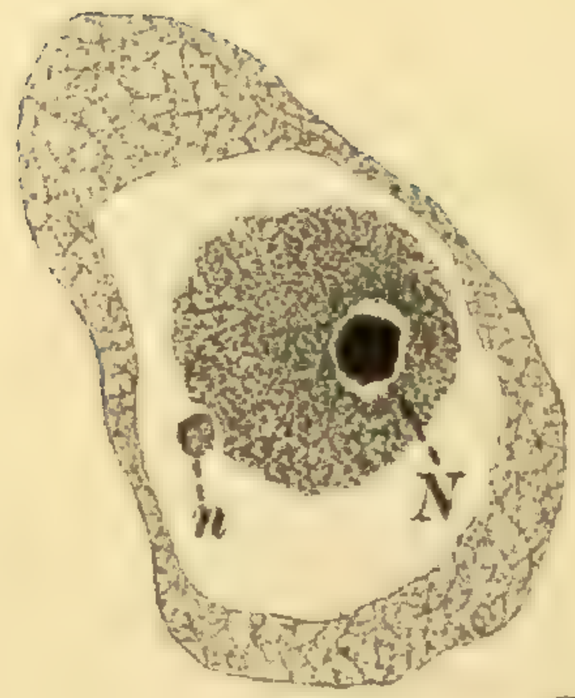

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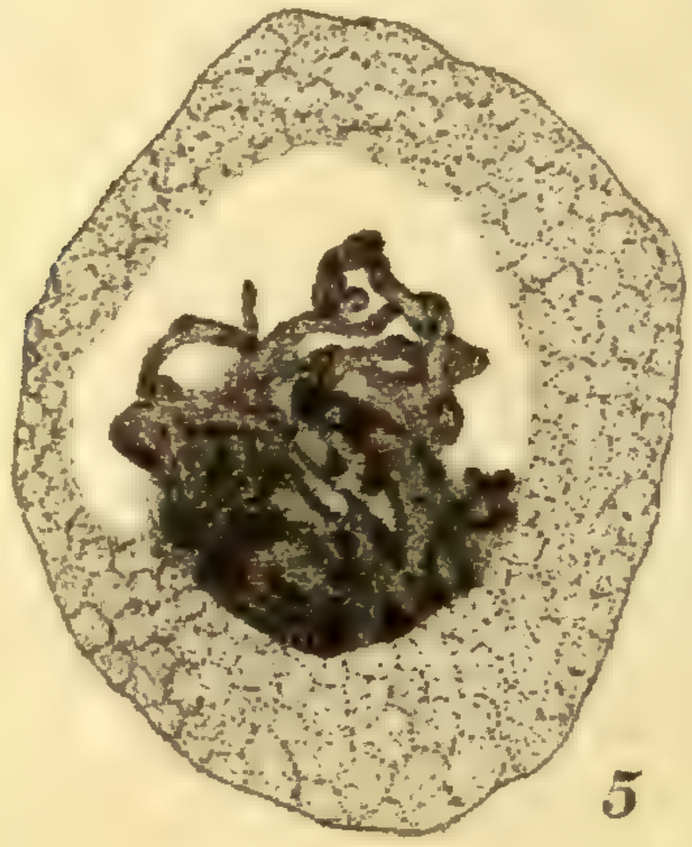

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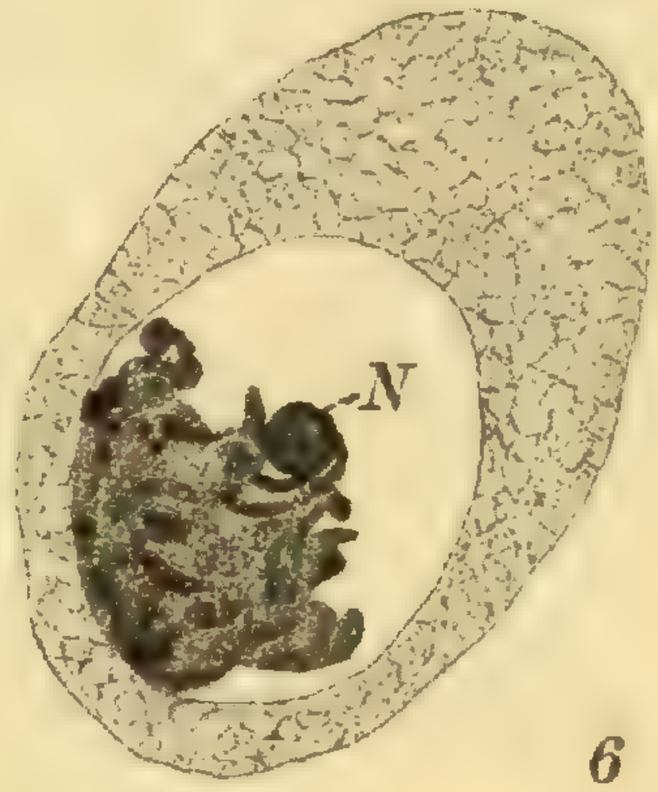

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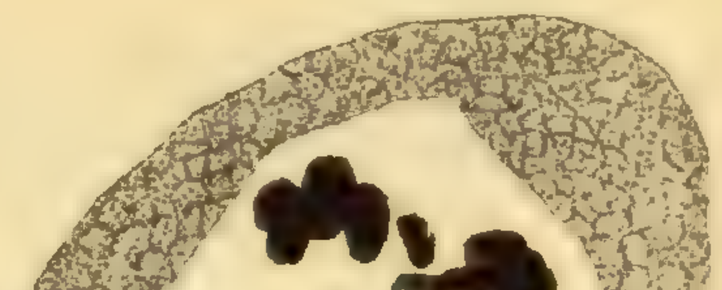

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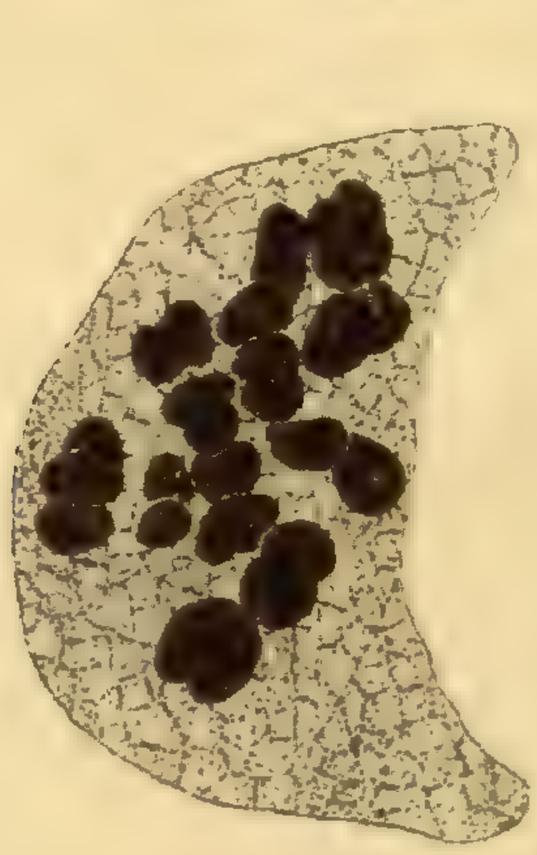

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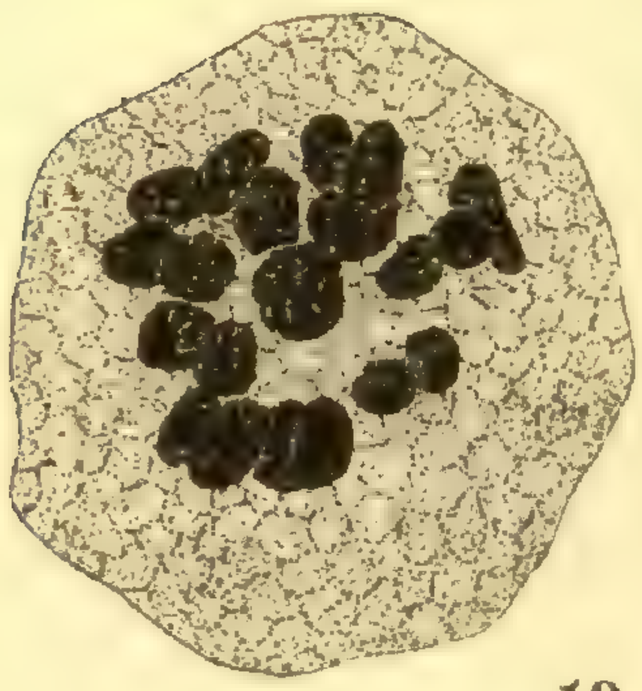
HANCE: POLLEN IN ZEBRINA PENDULA



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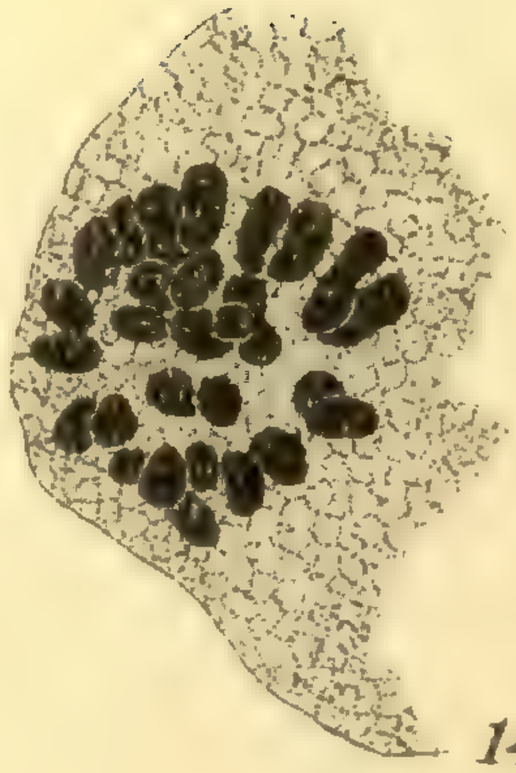

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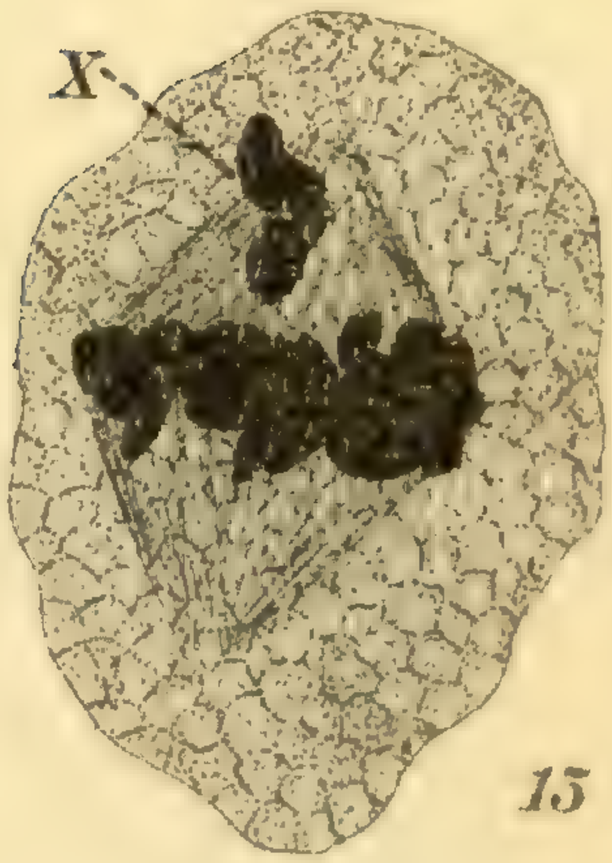

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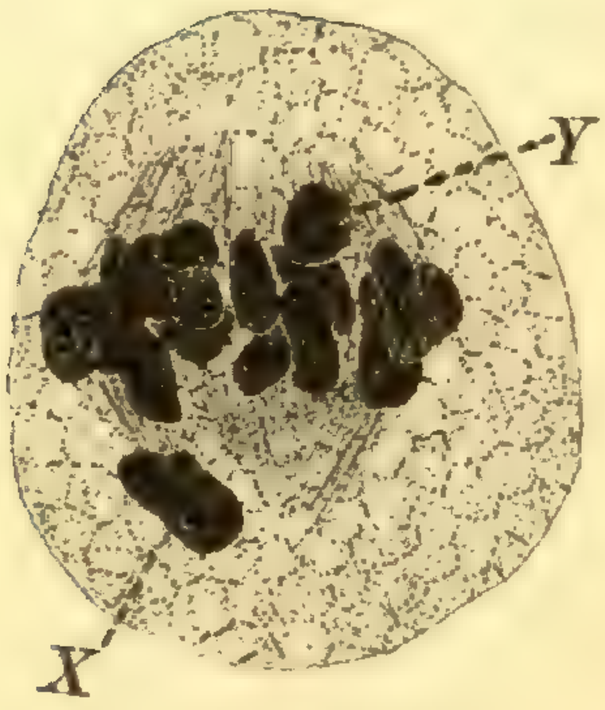

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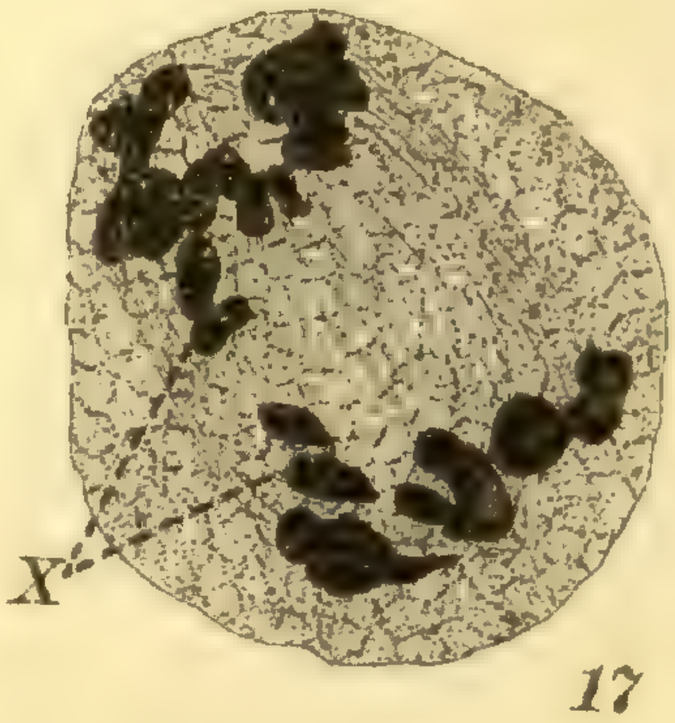

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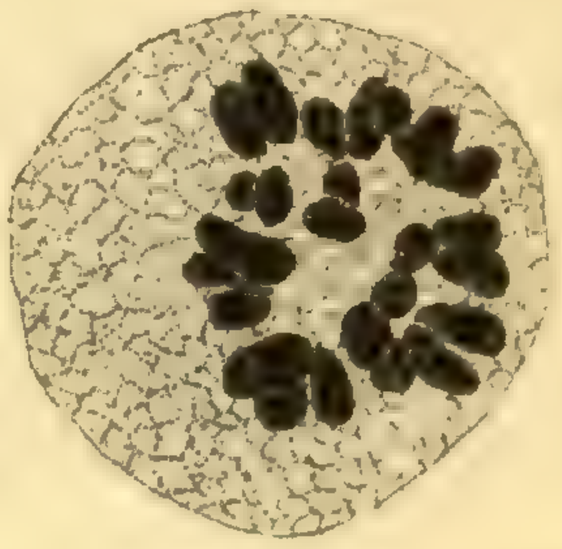

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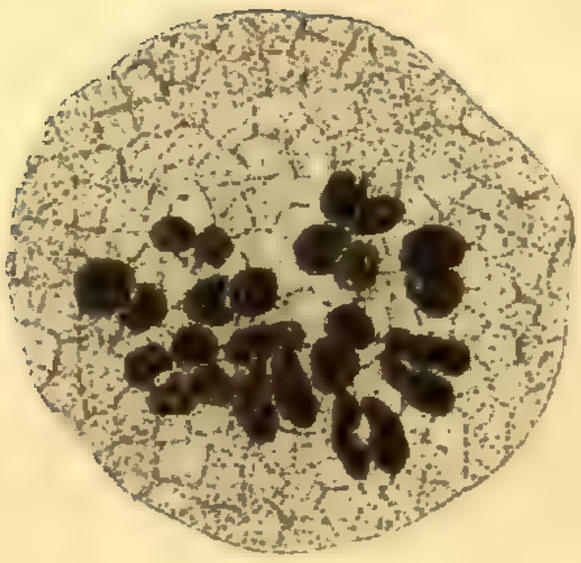

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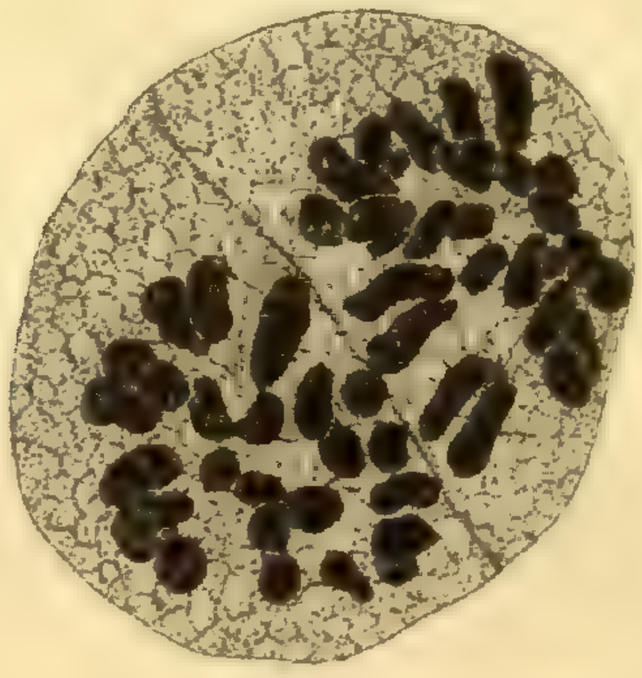

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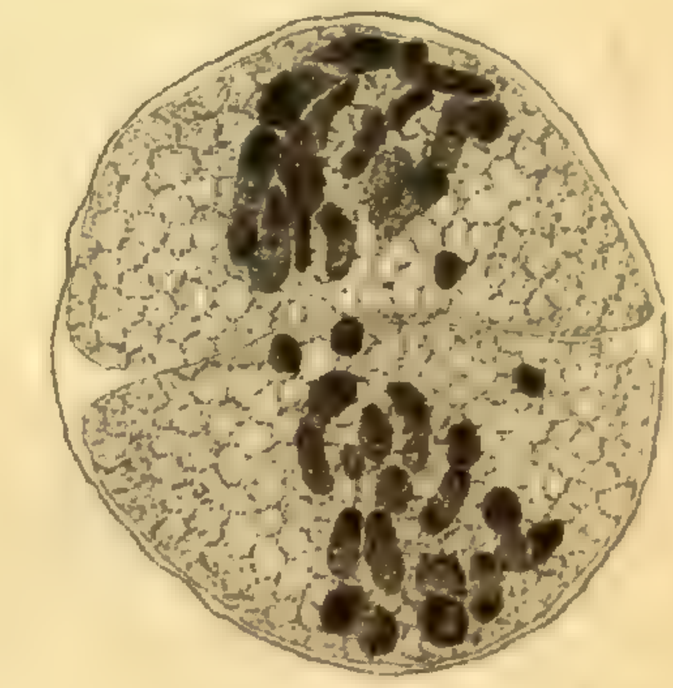

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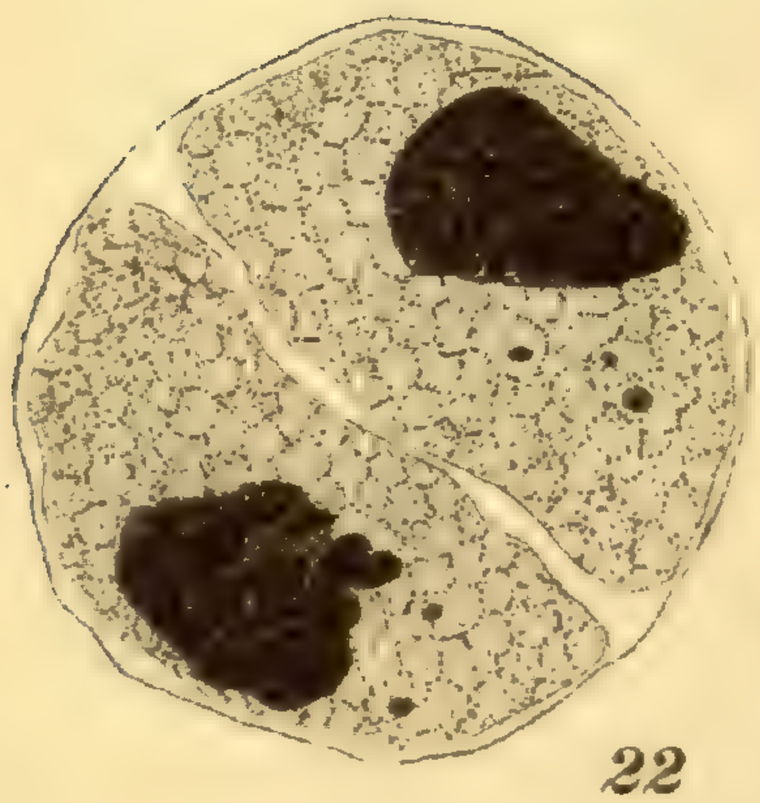

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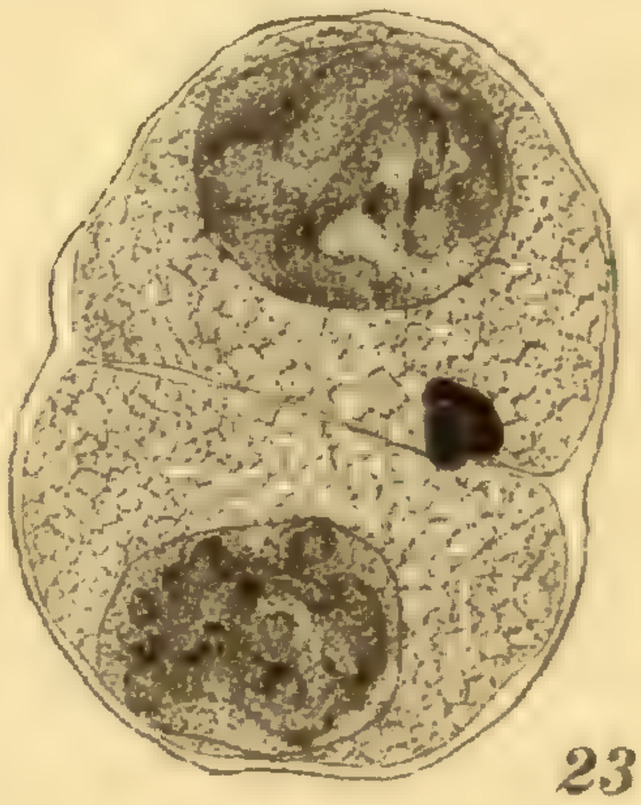

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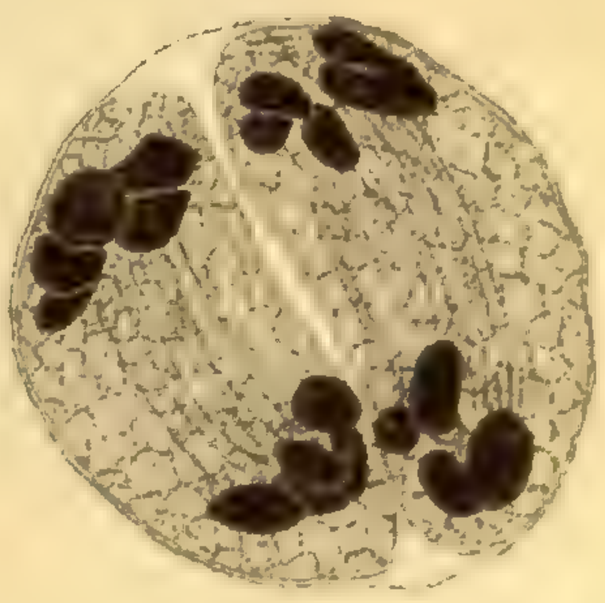

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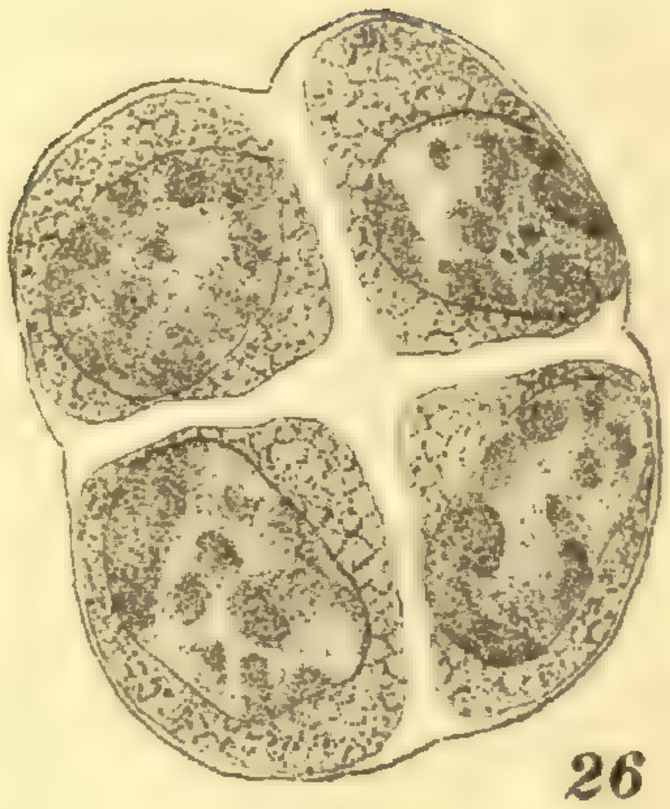

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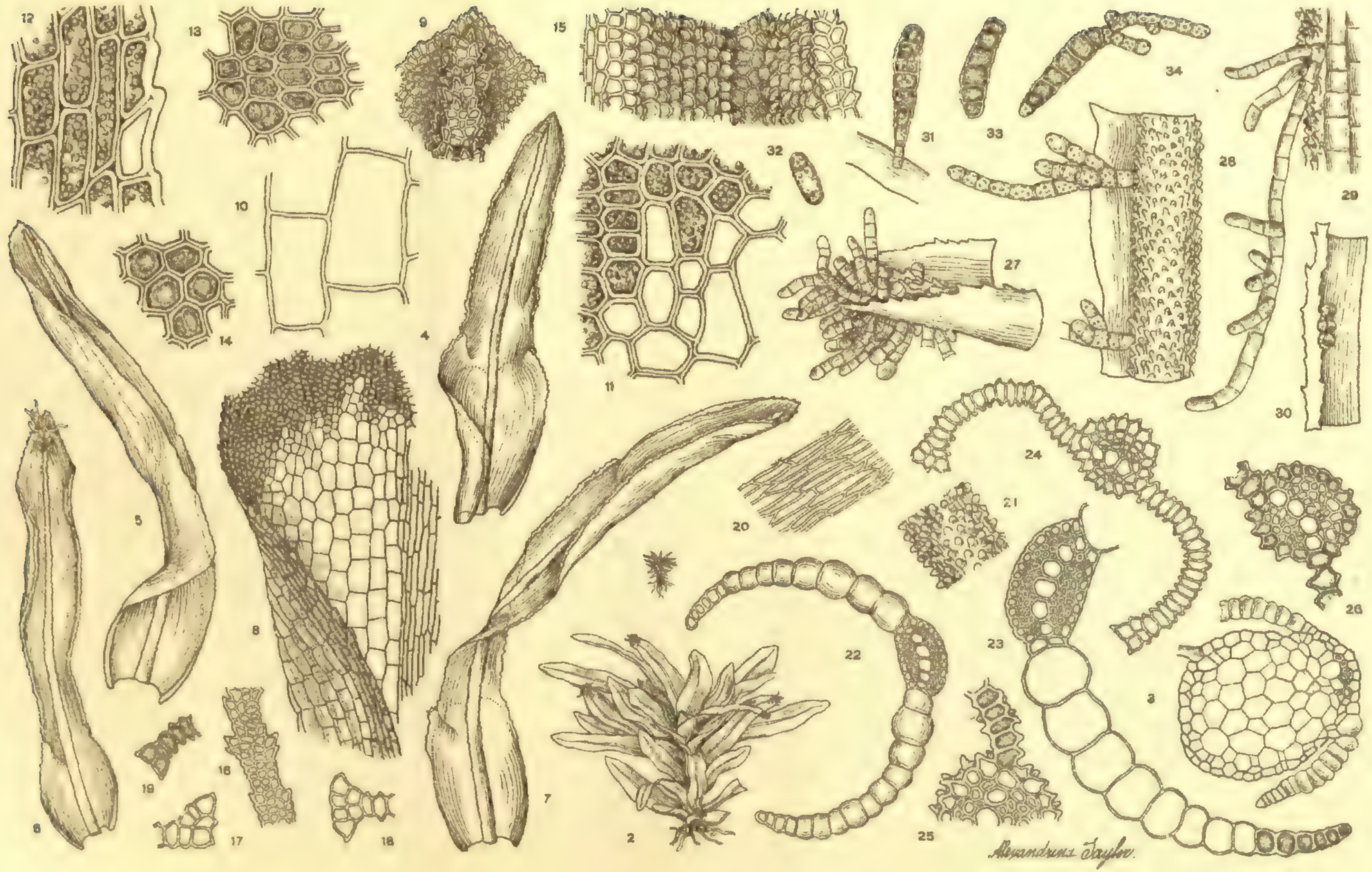
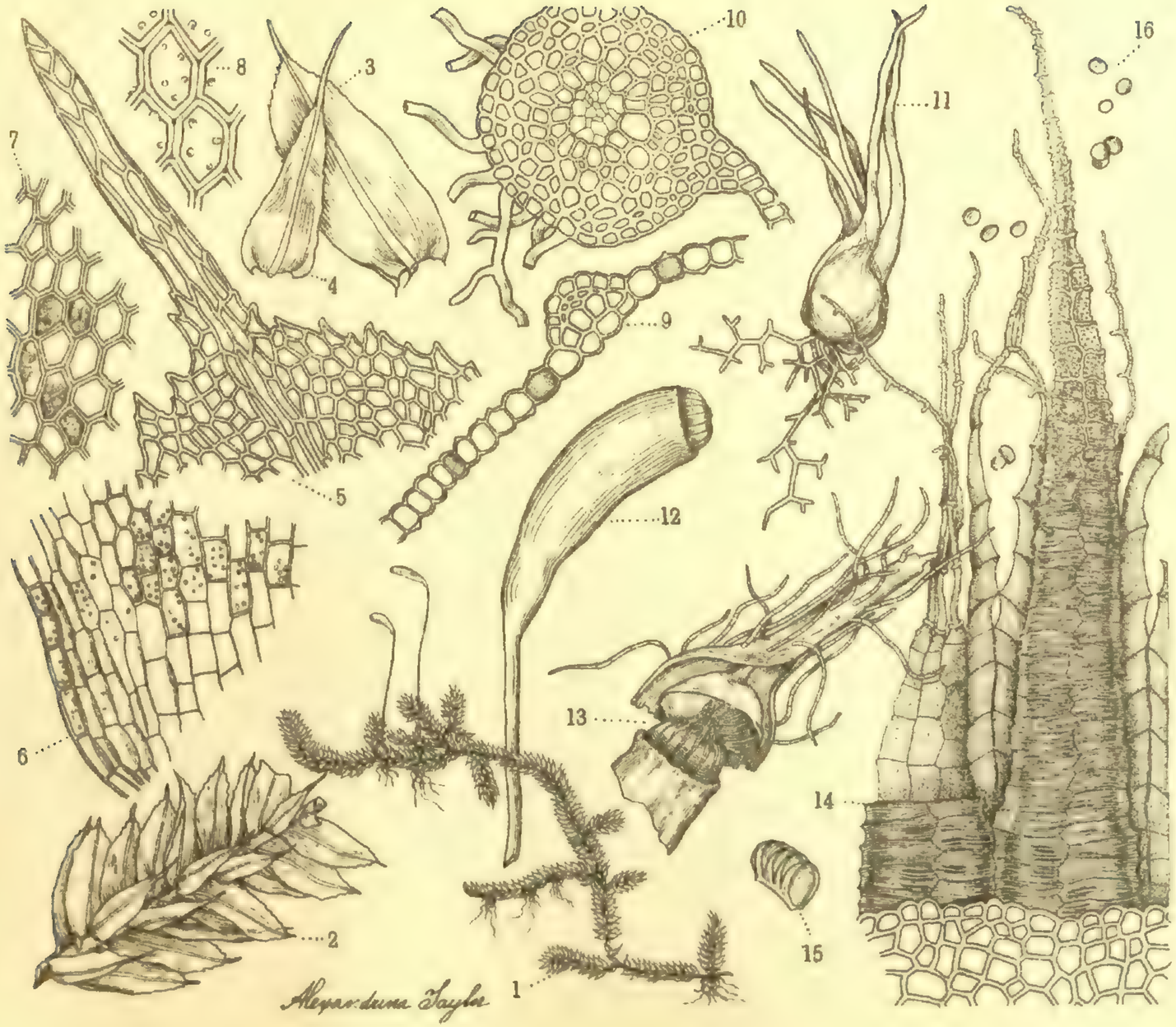
HANCE: POLLEN IN ZEBRINA PENDULA



SYRRHOPODON FLORIDANUS SULL.

HELIOTYPE CO., BOSTON.



RHACOPILUM TOMENTOSUM (SW.) BRID.

HELIOTYPE CO., BOSTON.

CYANEA LARRISONII ROCK

Vol. 42 No. 3

BULLETIN

OF THE

TORREY BOTANICAL CLUB

MARCH, 1915

New and rare Australasian mosses, mostly from Mitten's herbarium

H. N. Dixon

(WITH PLATE 9)

The rich material in Mitten's herbarium contains a large number of undescribed species, many of which are valid for publication. I propose in this paper to describe some of these from the Australasian region, together with some from the same region which have come to me from other sources, a few notes on other rare species being added. I hope later to describe further species from other geographical regions.

I have to thank Mrs. N. L. Britton and the authorities of the New York Botanical Garden for both the material on which most of these species are based and for further specimens needed to elucidate them; and also to the authorities at the Kew Herbarium for facilities for studying the material there.

Dicranoloma angustiflorum Mitt., sp. nov.

PLATE 9, FIGURE 1

Sat robustum, ad 4 cm. altum vel ultra. Habitu foliisque *D. grossialari* C. Müll. simile, sed folia paullo breviora (1–1.4 cm. longa), in subulam *minus attenuatam argutius densius serratam* angustata; costa *tenuior*, basin versus *sæpe pertenuis indistincta*, 40–50 μ lata, superne robustior, in subula bene definita, dorso *profunde canaliculato-prominens, dense spinuloso-denticulata; vix excurrens*. Cellulae subulae omnes elongatae, *latiusculae*, parietibus curvatis, incrassatis, porosis.

Perichaetium *praelongum*, ad 1.5 cm. altum, *totam setam obtegens, angustissime arcte convolutum tubulosum*, bractea interna

[The BULLETIN for February (**42**: 55–92. *pl. 2–8*) was issued March 2, 1915.]

mutica (?), proxima brevi-aristata, ceteris multo brevioribus, *brevissime* cuspidatis. Seta perichaetium vix superans, theca (unica visa) breviuscula, curvata, oblongo-cylindrica, collo abrupto haud strumoso.

HABITAT: "In dense forests, Gordon River, Tasmania, *Dr. Milligan*, 11.46." Herb. Mitten.

This is no doubt nearest to *D. grossialare* C. Müll., but the leaves present some marked differences in the narrower, thinner nerve (thin at base but not narrow as in the *Billardieri*-group), which is not excurrent, vanishing in the somewhat wide apex, instead of being prolonged into a finely filiform arista; the upper cells also of a somewhat different nature (the figure may be compared with my figures of *D. grossialare* in N. Z. Inst., Bull. 3: *pl. 1. f. 4*). The perichaetium, strikingly developed there, is still more remarkable in the present case; it fits the seta "like a glove," and it is difficult at first sight to persuade oneself that it is not actually the seta itself; the very short, almost invisible points to the median bracts help to bear out the illusion, and at the same time constitute a difference from *D. grossialare*, where they are longer and more conspicuous.

Dicranum (?§ HOLODONTIUM) **aucklandicum** Dixon, sp. nov.

PLATE 9, FIGURE 2

Gracile, laxe caespitosum, nigricans. Caulis circa 1 cm. altus, parce ramosus, flexuosus, haud radiculosus. Folia *remotiuscula*, *alcata*, *siccitate vix mutata*, apice solum leniter flexuosa, 4–5 mm. longa, e basi brevi-lanceolata sensim in subulam pertenuem *integerrimam acutissimam* attenuata. Costa sat valida, superne *aegre discriminanda*, totam fere subulam occupans. Cellulae alares numerosae, magnae, rubrae, auriculas pro more magnas instruentes; rete reliquum *angustissimum*, *per totum folium elongatum*, *peranguste lineare*.

Autoica? Flos masc. sat magnum, longe infra caulis apicem situs. Bracteae perichaetii e basi lata vaginante in subulam tenuem cito angustatae. Seta *vix 1 cm. longa*, tenuis, substricta. Theca minuta, deoperculata circa 2 mm. longa, elliptica, suberecta, leviter curvata subsymmetrica. Operculum haud visum. Peristomium omnino fere peritum.

HABITAT: "Auckland Island, New Zealand," in herb. Mitten. No further particulars are given. The specimen was marked

"*Dicranum Billardieri*," but this could hardly have reference to the present plant, which has no resemblance or affinity to that species. It was under the same cover with *Dicranum pumilum* Mitt., from Hermite Island, showing that Mitten had recognized its affinities.

The capsules are too old for the peristome to be properly examined, and I am in some doubt as to the proper place of the species. It appears in some respects to be intermediate between the sections *Arctoa* and *Holodontium*. The inflorescence is not certainly autoicous. The only ♂ flower I have seen was on a stem which certainly showed no immediate signs of producing a perichaetium, though the ♂ flower itself was fully developed; it appeared to be lateral, but might very well have been originally terminal with the stem prolonged by innovation.

It appears to be most nearly allied to the Hermite Island *D. pumilum*, which is also a New Zealand species. That, however, is a plant of denser growth, with closer, shorter foliation, and a quite different leaf acumen, which instead of being gradually and finely subulate is (while very narrow) flattened and remaining of some appreciable width to the very point, and as it often has an inconspicuous twist just below the apex, bringing that part of the subula into (narrower) profile, it frequently gives the impression of the tip being actually widened. The upper cells in *D. pumilum* are comparatively wide and short, so that the nerve is easily distinguished from the rest of the lamina, instead of being almost indistinguishable as here. The sporophyte is very similar in both species.

I know of nothing else like it among the antarctic species. *D. ramulosum* Mitt. differs in the shorter seta ("2-linearis") and—*e descr.*—markedly in the branching.

Didymodon calycinus Dixon, sp. nov.

PLATE 9, FIGURE 3

Terrestris; caules inter muscos et hepaticas aggregati, circa 1 cm. alti, simplices vel infra flores parce ramosi. Folia juniora pallide viridia, senectute fuscescentia, sat conferta, omnia subaequalia, erecto-patentia, sicca subcontorta, brevia, 2 mm. longa vel paullo ultra, e basi latiuscula breviter lineari-lanceolata vel

lingulato-lanceolata, *substricta;* caulina plura acutiuscula, *saepius aeque ac ramulina rotundato-obtusa*, perconcava, carinata, marginibus ad apicem fere *late recurvis* integerrimis. Costa *valida* (ad basin 120 μ lata) ad apicem vel infra soluta. Cellulae basilares *longiuscule rectangulares*, pellucidae, *parietibus firmis*, superne quadratae, vel quadrato-rotundae, 8–10 μ latae, subpellucidae, haud incrassatae, laeves. Perichaetium *bene exsertum*, bracteis internis *erectis, e basi convoluta margine superiore eroso-denticulato, in mucronem brevem strictum latiusculum abrupte angustatis*, e cellulis saepius elongatis laxioribus instructis.

Seta 1 cm. alta vel paullo ultra, rubra; theca elliptica vel breviter cylindrica, circa 2 mm. longa, aetate castanea, subpachydermata. Cellulae exothecii omnes, juxta fere ad orificium ipsum, elongatae, parietibus incrassatis, flexuosis. Peristomium parvum, *intense rubrum*, e dentibus 16 compositum inferne inter se adhaerentibus (faciliter tamen solutis), *coronam rubro-purpureum densissime lamellatam circa 60 μ altam* instruentibus, superne in crura bina ter longiora erecta *filiformia* remote articulata *densissime papillosa* divisis. Spori minuti. Operculum haud visum. Dioicum videtur.

HABITAT: in a boggy place in grass paddock, among rushes, Mt. Bruce, Wairarapa, New Zealand, September 18, 1913, *W. Gray 176.*

This appears to me to be a very well marked species, in the obtuse leaves with widely reflexed margins, and the exserted convolute perichaetial bracts. The nearest species is perhaps *Trichostomum Cockaynii* R. Br. *ter.*, which resembles it somewhat in the leaves, but has quite different perichaetium and exothecium structure.

The short erect divisions of the peristome seem to refer this plant best to *Didymodon*, in spite of the exserted perichaetium; but the filiform, highly papillose crura are rather more like those of *Barbula*, and it might perhaps not improperly be placed in the section *Streblotrichum* of that genus. It is in any case very different from the New Zealand species (*B. calycina*) of that group.

Cinclidotus australis Dixon, sp. nov.

PLATE 9, FIGURE 4

Stirps elongata, robusta, submersa, *mollis*, habitu *C. fontinaloides*, superne olivacea, inferne nigricans; caulis distanter ramosus, ad 8 cm. longus, infra foliorum vetustorum costis

vestitus. Folia conferta, flexuosa, erecto-patentia, *haud falcata*, faciliter emollita, sicca valde contorta, 4–5 mm. longa, basin versus 1 mm. lata, carinato–concava, *e basi oblonga breviter late lanceolata, sensim ad apicem latum obtusum* angustata, marginibus infra angustissime reflexis, supra planis; integerrimis, *toto margine incrassato nec bistratoso;* costa valida, prope basin ad 150 μ lata, supra sensim angustata, *ad apicem vel paullo infra soluta;* sectione duces plures (6 vel ultra) in seriebus duabus, fasciculos stereidearum duos, cellulas externas parvas incrassatas exhibens. Rete perdensum, e cellulis *minutis* (5–8 μ) irregularibus, plerumque angulatis, subincrassatis, opacis, inferne sensim majoribus elongatis rectangularibus, infimis longe lineari-rectangularibus pellucidis laxiusculis instructum; marginalibus basin versus seriebus circa sex latioribus, sat laxe rectangularibus, *limbum pellucidiorem, circa quartam partem folii longitudinem attingentem*, formantibus, *serie unica marginali e cellulis multo brevioribus subquadratis* composita.

Fructus ignotus.

HABITAT: at bottom of creeks, Kaitangata, Otago, New Zealand, September, 1892, *D. Petrie.*

A very interesting species of a genus hitherto unknown in the southern hemisphere. The gradually tapering but obtuse leaves with the nerve ceasing below the apex are unlike any, I believe, of the northern species, while the mode of thickening of the leaf margin is also, I believe, unique in the genus, and unusual in the whole range of mosses, being effected not by an increase in the number of cell-layers, but in the vertical diameter of the cells, resulting in a thickening of varying degree, greater towards the base of the leaf, but causing at times an increase of at least three times the normal thickness of the lamina.

It is much to be hoped that this plant should be re-found—it should not be difficult—and further studied.

MACROMITRIUM EROSULUM MITT. AND ALLIED SPECIES

These New Zealand species form a somewhat difficult group, and several species have been described on what appear to be unsatisfactory grounds. Mitten compares his *M. erosulum* with *M. prorepens* (Hook.) Schwaegr., separating it by the direction of the leaves when dry, their narrower bases, upper portion longer, more obtuse, cells larger and less obscure (the suspected difference in inflo-es cen ce is in no way supported, I believe, by later observations). I

have compared Mitten's specimens with Hooker's type of *M. prorepens* (Dusky Bay, New Zealand, *A. Menzies 70*), and I have no doubt that some of these differences are illusory. Mitten, I think, and others who have studied Menzies' plant do not make allowance for the fact that it is as a whole a somewhat starved form; consequently the leaves are as a rule very short and in proportion wide—more oblong and less ligulate—and as a natural consequence very little crisped or twisted when dry. This latter feature has led to *M. prorepens* being contrasted by authors with other plants showing a more highly flexuose, more spirally twisted condition in the dry state. The position of the leaves when dry is in *Macromitrium* no doubt a highly important character; but it may be overstrained. The leaves in *M. prorepens* and this group of species are normally somewhat spirally twisted when dry, and always then more or less strongly circinate-incurved at the apex; where the branches are short and densely foliate the twisting is more marked and the leaves less crisped; where the branches are more elongate and the leaves somewhat less crowded they are less spirally contorted and the apical incurvation is more noticeable and more pronounced; these two forms may often be observed more or less distinctly on the same plant. On the type specimen of *M. prorepens* the leaves are on most of the branches so short that in the dry state they are scarcely more than appressed to the stem; they could not curl if they tried; and to make this a specific character is very much to deny the family resemblance of a convict to other members of his family on the ground that their hair curled while his did not! That this close, short, non-twisting foliation is not the normal character of *M. prorepens* is proved by the fact that here and there a better developed branch shows the leaves longer, more ligulate, incurved at the apices when dry and slightly twisted. In the Handbook of The New Zealand Flora it is suggested that the cells are "papillose" in *M. erosulum*, "scarcely papillose" in *M. prorepens*, but this is in no way borne out by the specimens; it is in fact the papillae on the surface of the cells in *M. prorepens* that for the most part produce the obscurity which is a character of the species.

Several indeed of the specimens at Kew of *M. erosulum* Mitt., determined by Mitten himself, are quite identical with *M.*

prorepens (Hook.) Schwaegr. The same is the case with *M. submucronifolium* Hampe & C. Müll. I have examined the type of this in Hampe's herbarium, and find no difference of any kind. The authors compare it with *M. mucronifolium* (Hook. & Grev.) Schwaegr., from Central and South America, and it is no doubt nearly allied to that; but it would have been more to the point if the authors had compared it with *M. prorepens*, which must have been known to them. They do not, however, refer to it, and neither in the description nor in the specimens of *M. submucronifolium* do I find any character in the slightest degree at variance with that species.

It may be pointed out that there is nothing in the specimen of *M. prorepens* to justify or explain the phrase in C. Müller's description (Syn. 1: 725) of the basal cells as "minute quadratis" they are narrowly linear as in all the allied species, and the phrase is probably due to an error of writing or of typography.

I have not been able to see a specimen of *M. oocarpum* C. Müll., but judging from the description I should feel moderately certain that it is only *M. prorepens*. The very short seta is the only character suggesting a difference, and I shall refer to this character as well as to the areolation in the group later on.

It is necessary in order to explain the true relationships to make some remarks on the character of the areolation. Brotherus (Musci, Engler & Prantl, Nat. Pflanzenfam. 1^3: 484. 1903) divides the species containing the group now being dealt with into two series, thus:

Ka. Zellen der Lamina klein, etwa 0.025 mm. mit niedrigen Papillen.

Kb. Zellen der Lamina 0.05–0.07 mm., durchsichtig mit hohen, zuweilen stacheligen Papillen.

The broad distinction is a clear and well established one, but I cannot follow him in the actual measurements. I have seen no species—certainly there are none among the plants already mentioned—in which the cells approach the minuteness of 2.5 μ. Careful measurements of a good many leaves of *M. prorepens* give a fairly constant size to the upper cells, ranging from 7 to 11 μ; while in the larger-celled species they are similarly constant, ranging from 9 to 14 μ. In neither case therefore do the measure-

ments agree with those given by Brotherus. Moreover the cells of *M. ligulifolium* Broth. are there cited as in the former category (2.5 μ), while the original description gives them as 12–15 μ. I suppose therefore some error in the "Musci." The distinction in the character of the areolation is however a very real and marked one, and well described by Brotherus; but it depends less on the size of the cells than on the character of the papillæ. The cells in fact in the first named group though smaller are not greatly smaller than in the latter. In these they are large, arranged in regular longitudinal series, and pellucid; each crowned with or rather rising into a large prominent conical papilla or tubercle, which may be minutely bifurcate above, but inconspicuously. In the other group the cells while a little smaller are of the same form and arrangement, but this is masked by the papillae with which they are covered,—lower, dense, numerous, and much branched, so as greatly to obscure both the cells and their walls, rendering their size and outline very ill-defined (cf. PLATE 9, FIGS. 5, 6).

This character once appreciated will easily separate *M. erosulum* from *M. prorepens*, and will show into which category doubtful plants passing under the name of *M. erosulum* must go. That all the New Zealand species of this group with hairy calyptra belong to one or other of these two species I am not prepared to say. In any case the "*M. microstomum*" of the Flora of New Zealand is, I think, generally agreed to belong here and not to the true Oceanic species; I have practically no doubt that *M. papillifolium* C. Müll. is identical with *M. erosulum*. *M. grossirete* C. Müll. and *M. rigescens* Broth. & Dixon have the capsules gymnostomous, and perhaps rather narrower, and these may be characters of sufficient value—if stable—to allow them distinctive rank.

Mitten named certain plants in his herbarium and at Kew *M. abbreviatum*, from the short seta. In his original specimens it varies from 2 to 3 cm. Within certain limits this is no doubt a good character. But in the allied species *M. prorepens* it varies very markedly; on the same stem setae of 2 cm. and even less occur with others reaching 4 cm. And in specimens from Lord Howe Island, *McGillivray*, which Mitten has named (on the strength of this character) *M. abbreviatum*, but which indubitably belong rather to *M. prorepens*, the seta is absurdly—perhaps pathologically—

short, so that the capsule is scarcely emergent. Too much stress must therefore not be placed on the exact length of the seta; and for this reason I consider inseparable from *M. erosulum* the plant of T. W. Naylor Beckett's to which Brotherus has given the manuscript name of *M. perpapillosum*. I can find no difference between this and Mitten's *M. erosulum* in the leaves or fruit, only the seta is longer than usual, ranging from 2 to 4 cm. on one tuft, and from 2.5 to 5 cm. on another.

Macromitrium (EU-MACROMITRIUM, GONIOSTOMA) **Petriei** Dixon, sp. nov.

PLATE 9, FIGURE 7

Sat robustum; caulis elongatus, ramis erectis, *graciliusculis*, substrictis, *elongatis* (ad 2 cm.), simplicibus vel hic illic divisis; folia *pro more laxiuscula*, *suberecta substricta*, *siccitate arcte erecto-appressa*, *apice tantum circinato-incurva*, 2–2.5 mm. longa, e basi elongata elliptica lanceolata, sensim acutata, apice *plerumque acuta*, *saepius mucronata*, marginibus planis vel irregulariter reflexis, argute eroso-papillosis. Cellulae pellucidae, haud incrassatae, 8–14 μ latae, *eis M. erosuli similes*. Perichaetialia parva, subsimilia. Seta 1 cm. vel paullo ultra, theca elliptica brevicolla, 2 mm. longa, operculo subulirostro aequilongo. Calyptra longipilosa. Spori valde inaequales, interdum ad 50 μ lati, papillosi. Dentes peristomii breviusculi, fusci, densissime papillosi, opaci.

HABITAT: Clinton Valley, Te Anau, New Zealand, *D. Petrie*.

Although in leaf-structure this is scarcely separable from *M. erosulum* (the leaves however are longer and more acute than is usually at least the case there), the long straight branches, rather slender on account of the less dense foliation, and the leaves suberect, not spreading when moist and closely appressed except at the points when dry seem to entitle it to specific rank. Both *M. prorepens* and *M. erosulum* vary very considerably in size and habit and length of branches, but I have seen nothing among them which seems to approach the present plant, and I think it must deserve specific rank. It bears a much closer resemblance to *M. rigescens* Broth. & Dixon, a gymnostomous species; in fact it occupies almost exactly the same relationship to *M. erosulum* as *M. rigescens* does to *M. grossirete*; Mr. Petrie's plant only

showing a few other minor differences from *M. rigescens*, e. g., the branches more slender and rigid, the leaves a little longer and narrower, the operculum with a longer subula.

Pohlia (EUPOHLIA) **novae-seelandiae** Dixon, sp. nov.

PLATE 9, FIGURE 8

Dense caespitosa, pallide viridis subnitida, caules vix 1 cm. alti, simplices, foliis inferioribus perpaucis, minutis; superioribus dense comatis multo longioribus, ad 2 mm. longis, peranguste lanceolatis, valde acutis, subdecurrentibus, *parum concavis*, *marginibus omnino planis*, supra medium folium magis magisque acute denticulatis; costa basi valida, supra sensim angustata, percurrens vel saepius in mucronem peracutum integrum vel subdenticulatum excurrens. Cellulae *angustissime lineares parietibus firmis nec incrassatis*, basin versus sensim latiores, anguste rectangulares, ad alas perpaucae latiores, late rectangulares.

Dioica. Flos masc. *gemmiformis*, terminalis. Folia perichaetialia interna angustiora, breviora. Seta 1.5–2 cm. alta, gracilis, theca *inclinata*, subcylindrica vel angustissime piriformis, cum collo angusto subaequilongo 3–4 mm. longa, operculo *alte peracute conico*. Annulus *latus*, persistens. Exothecii cellulae *elongatae*, *angulis rotundatis*, *parietibus leniter curvatis*, subincrassatis. Peristomium bene evolutum, flavescens, dentes anguste lanceolati, infra confertiuscule lamellati dense minutissime papillosi, supra densiuscule articulati, *grossius papillosi*. Endostomii processus e membrana *tertiam partem tantum longitudinis aequante* late lanceolati, *dentibus subaequilongi*, pallidi, *minute papillosi*, *late rimosi*. Cilia *rudimentaria*.

HABITAT: Evans Flat, Tuapeka County, Otago, New Zealand, October, 1891, *D. Petrie*.

A species of somewhat doubtful position in the genus; the leaf-structure, the rudimentary cilia, and perhaps the exothecium tissue, would place it in *Eupohlia*, while on the other hand the high basal membrane and well-developed processes of the inner peristome seem to refer it to Lamprophyllum. In any case it is nearly related to *P. leptocarpa* (v. d. B. & Lac.) Fleisch., and as this is usually ranked under *Eupohlia* I place the present species there. The plane-margined leaves, the inflorescence and peristome, both inner and outer papillose, distinguish it from the above-named and other species. Among the New Zealand species there are none very closely allied, *P. nutans* being perhaps superficially

most like it. The capsule resembles that of the smaller forms of *P. elongata.*

Anomobryum densum Dixon, sp. nov.

PLATE 9, FIGURE 9

Dense caespitosum, terrestre; caules infra arcte compacti, terra intertexti, haud radiculosi, vix 1 cm. alti, simplices vel sub floribus innovantes, *stricti*, *rigidi*, *fuscescentes*, sicci madidique *arcte julacei*, apice angustati, subobtusi. Folia *arctissime imbricata*, *perconferta*, *minuta* (.5 mm. longa) *cochleariformia*, brevissime ovata vel omnino orbicularia, *obtusissima*, marginibus erectis integris vel subintegris; costa sat valida, fusco-aurantiaca, ad basin dilatata rubra, *paullo infra apicem evanida;* sectione prope basin duces circa quinque dorsales, cellulas ventrales duas magnas subinflatas, rete internum substereideum exhibens. Rete folii *densum*, e cellulis superne parvis (12–20 μ × 8–14 μ), *breviter* irregulariter *late rhomboideis*, inde sensim majoribus, inferioribus late rectangularibus, *infimis pulchre rubris*, omnibus angulis rotundatis, pellucidis, auratis, *incrassatis*.

Folia caulis fructiferi comalia angustiora, longiora, *obtusa*, areolatione elongata; perichaetialia intima parva, *lanceolata*, *subobtusa*, *denticulata*, tenuicostata, cellulis multo angustioribus supra linearibus. Paraphyses permultae, filiformes, longae, e perichaetio plus minusve excedentes. Vaginula brevis. Seta 1–1.25 cm. alta, rubra, superne pallidior, apice arcuata, inde fructus subpendulus vel horizontalis. Theca e collo anguste defluente breviter ovato-pyriformis, castanea, operculo convexo vel obtuse conico; exothecii cellulae sat regulariter rectangulares, parietibus firmis, orificium versus sensim minores. Annulus? Peristomium aurantiacum, dentibus lanceolatis, .3 mm. longis, dense lamellatis, minutissime obscure papillosis, superne pallidis laevibus; endostomii processus e membrana basilari *circa tertiam partem longitudinis dentium vel paullo ultra* aequante angusti, *lineari-lanceolati*, dentibus aequilongi, pallidi, vix papillosi, *angustissime rimosi; cilia nulla vel omnino rudimentaria*. Spori 20–24 μ, fulvi.

HABITAT: South Island, New Zealand, 1888, *R. Helms*. Ex herb. J. Cosmo Melvill sub nomine "*Bryum blandum* det. Boswell" acceptum.

This very distinct species I have only in small quantity; it was probably gathered in the Paparoa Range,* as were nearly all Helms' plants sent to Mr. Melvill with this one; it is much to be

*Since the above was in print I have received a further specimen labelled "Paparoa Range, 1885."

desired that it should be refound. It has nothing in common with *Bryum blandum* except the obtuse apex of the concave leaves. It is very distinct in the densely crowded tightly imbricated small rounded leaves, the character of the areolation, and the imperfect peristome.

Philonotis australis surculigera Dixon, var. nov.

Caules *stricti*, condensati, basi *haud tomentosi*, 4–5 cm. alti, simplices, foliis patentibus haud falcatis; *per totam longitudinem inter folia surculis gemmiformibus minutis foliosis dense confertis omnino obtecti.*

HABITAT: Otago, New Zealand, *D. Petrie.*

This plant was received from Mr. Petrie with a note in the hand of W. Bell indicating that he considered it a *Bryum*, "probably new, and may stand near *Wahlenbergii*." In spite of its resemblance to this species, however, it is a *Philonotis*, of a very striking appearance, but the structure of the leaves shows it to be too near to *P. australis* (Mitt.) Jaeg. to be specifically separated. The stems are densely clothed, so as to be almost hidden, nearly from the very base, with innumerable brood-bodies, in the form of minute ramuli, of the nature of dwarf plantlets, each composed of a short stem with numerous ovate-lanceolate sharply denticulate nerveless leaves.

Somewhat similar forms occur in several of the European species of *Philonotis*, but in those I have seen the branchlets are usually almost normally formed, but small, numerous and very caducous; here they are much specialized and more distinctly of the nature of "brood-bodies." In size they bear about the same proportion to the leaves as do the gemmae of *Pohlia proligera* Lindb. to its leaves.

Thamnium baculiferum Dixon, sp. nov.

PLATE 9, FIGURE 10

Robustum, caulis secundarius rigidus, 7 cm. longus vel ultra, curvatus, supra *sub-pinnate ramosus*, *frondem percomplanatam* instruens; inferne simplex vel hic illic *surculum tenuem perfecte strictum*, *teretem baculiformem* gerens. Rami inaequales, complanato-compressi, hic illic divisi, ad 3 cm. longi, 4–5 mm. lati, virides, *nitentes*. Folia *complanata*, paullo decurva, subconcava,

lateralia uno margine late, superiora et inferiora marginibus ambobus angustius inflexis, *magna*, 3 mm. longa, medio folio 1 mm. lata, late oblonga, basi paullo dilatato ad insertionem angustiore, supra *late rotundata apiculata*, *apicem versus grosse inaequaliter dentata;* madida leniter striata, sicca *pluries profunde plicata*. Costa infra valida, supra medium cito attenuata, *longe infra apicem soluta*, *opaca*, dorso *laevis*. Rete *perdensum*, cellulis medianis anguste lineari-rhomboidis, omnibus parietibus tenuibus, eae apicem versus breviores, latiusculae, regulariter rhomboideae, circa duplo longiores quam latae; infra minime mutatae, paullo tamen elongatae, *angustissimae*, ad angulos extremos tantum paucae paullo latiores, bistratosae, obscurae, *maculam minimam alarem inconspicuam opacam* formantes; omnes densissime chlorophyllosae, *laeves*. Folia stipitis squamiformia, infima aeque ac illa surculorum baculiformium acuminata squarroso-reflexa, membranacea.

Cetera ignota.

HABITAT: Waikopiro, Hawkes Bay, New Zealand, *S. Chadwick*, comm. G. Webster.

Brotherus writes that this—unless it should be *Th. neckeroides* (Hook.) B. S. G.—is certainly a new species. I have examined the type of *Hypnum neckeroides* in the Hooker herbarium at Kew; it has non-complanate leaves, the nerve sharply toothed at back, and reaching nearly to the narrowed though subobtuse apex; while the upper cells are small and rounded. It is a quite different plant from the present. Moreover it appears that Menzies' plant was erroneously stated to come from "Dusky Bay, N. Z." It was really one of his North American gatherings, and the species is, so far as is known, confined to the west coast of North America. In any case it has no near relationship to our species, which is very closely allied to *Th. arbusculans* (C. Müll.) Jaeg. from Chile and western Patagonia; in fact Dusén's specimens of that plant only differ in the less plicate leaves, the thinner nerve, and more pellucid non-chlorophyllose areolation—the latter character possibly depending partly at least on the greater age of the specimens. Dusén's specimens, however, show none of the rather striking rod-like shoots from which the present plant is named. These are peculiar; those on the few stems I have seen are perfectly straight, up to an inch in length, and terete except for the minute squamiform leaves.

Judging from Dusén's specimens of *Th. arbusculans* Mr. Chadwick's gatherings represent a young, not fully grown form of the plant.

Thamnium latifolium elongatum Dixon, var. nov.

Caulis primarius filiformis, secundarius *pendulus flexuosus mollis, semipedalis et ultra*, subpinnatim, *distanter brevi-ramulosus*, ramis 1–2 cm. longis. Cetera ut typ.

HABITAT: Mt. Bruce, Wairarapa, New Zealand, June 19, 1913, *W. Gray 200*. "Probably growing pendent from a tree with *Meteorium*" [i. e. *Papillaria*], W. Gray *in litt.*

There has been some little doubt as to the identity of the New Zealand species with *Porotrichum latifolium* V. d. B. & Lac. of Java; partly on grounds of geographical distribution, partly, perhaps, on the ground that the New Zealand plant is as a rule more densely and repeatedly branched and less flexuose than the Javan (the New Zealand plant was first described by Lindberg as *Th. australe*, but was afterwards referred by Kindberg to *Th. latifolium* [V. d. B. & Lac.]. Kindb.). If this is the case the plant under consideration should remove all hesitation on that score, for it comes much nearer in habit to the Javan form, though far longer (some stems reaching to 8 inches in length); and in fact if the plant figured (Bry. jav. *pl. 188, f. 2*) were three times the length, it would give a very fair representation of the present remarkable form.*

Pterygophyllum distichophylloides Broth. & Dixon, sp. nov.

PLATE 9, FIGURE 11

E. minoribus generis, habitu omnino fere *Distichophyllorum* majorum, siccitate tamen foliis valde crispato-contractis caulem saepe haud obtegentibus. Color viridis, vetustate aliquando rubescens. Caulis, ut paret, prostatus, inferne radiculosus, 2–3 cm. longus, parce ramosus, valde complanatus; folia madida pulchre imbricata, dorsalia 4-seriata, arcte appressa, lateralia patentia, complanata, ventralia 2-seriata appressa; sicca *valde crispata contractaque, inde caule pallido detecto conspicuo.* Folia dorsalia circa 2 mm. longa, *latissime cordato-ovata* (*ea series medi-*

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*Since writing the above I have received a further specimen from Mitten's herbarium, as "*Isothecium pandum* H. f. & W., New Zealand, *Kirk*."

anae suborbicularia) *obtusa vel obtuse apiculata*, lateralia e basi angustiore *spathulato-oblonga*, 3 mm. longa, *acute apiculata*, omnia marginibus planis, *subintegris vel eroso-crenulatis*, perpellucida; costa supra tenuis, flexuosa, ad ¾ folii attingens, nec furcata, ad basin dilatata. Rete laxum, e cellulis hexagonis, supra (prope costae summitatem) 30–35 μ, latis, pellucidis, apicem et margines versus *paullo minoribus*, *1–2 seriebus marginalibus multo minoribus*, limbum aegre notatum formantibus; basin versus multo laxioribus, elongate hexagonis, hyalinis; parietibus omnibus tenuibus.

Cetera ignota.

HABITAT: near Auckland, New Zealand, 1892, *D. Petrie 800.*

This was submitted to Dr. Brotherus, who replied that it appeared to be a very distinct species from the rest of the genus. The habit and the subentire leaves mark it at once; while the species of *Distichophyllum* with unbordered leaves (*D. microcarpum* [Hedw.] Mitt., etc.) differ radically in the minute areolation of the marginal and juxta-marginal portion of the leaves. Here the cells towards the margin are only slightly reduced in size, except those of the actual marginal series, and these are of quite a different character from those of the *Distichophylla* mentioned.

TAXITHELIUM POLYSTICTUM (Mitt.) Jaeg.

Among some mosses sent me by Mr. W. Gray from Mt. Egmont, New Zealand, collected in January, 1912, I found a stem, with a single capsule, of a *Taxithelium*, which on comparing with the original of *Hypnum polystictum* Mitt. at Kew I found to be identical with that species; the only difference being that the stem leaves there usually want the longer, acuminate points shown in the Mt. Egmont plant, are in fact more like the branch leaves. The Kew specimen however is a mere scrap, and does not show the stem leaves to advantage (Mitten's description in the Handbook of the New Zealand Flora simply says, "leaves broadly ovate, shortly acuminate," making no distinction between stem and branch leaves). A stem from Mitten's herbarium shows several of the stem leaves with the abrupt acuminate points. As the fruit has not been recorded I append a short description:

Perichaetium sat magnum, 3.5 mm. altum, pallidum, cylindricum, bracteis numerosis, externis parvis, patentibus, breviter aristatis, dentatis, medianis suberectis, argute dentatis, longius

aristatis, internis pluribus convolutis, erectis, in acumen loriforme vel subaristatum dentatum attenuatis. Seta 1.5 cm. longa, omnino laevis. Theca *Plagiothecii*, inclinata, oblongo-cylindrica, curvata, brevicolla, 2 mm. longa; exothecii cellulae isodiametricae, subincrassatae, collenchymaticae. Peristomii dentes pallidi, infra dense alti lamellati, transverse striolati, linea media recta, supra conferta articulati, pellucidi, sublaeves; processus peranguste lanceolati, anguste rimosi, parce papillosi. Spori circa 16 μ. Cetera inquirenda.

The systematic position of this species—beyond its undoubted standing in the subgenus *Polystigma*—is not very clear. The branches are slightly compressed with the lateral leaves spreading, but only moderately so; the alar cells form a distinct group of abruptly enlarged, hyaline, somewhat vesicular cells, and the upper ones are very small and narrow, each with a row of well marked but minute papillae, the marginal row of cells being hyaline and smooth. The inflorescence is doubtful, probably dioicous.

Rhynchostegium cylindritheca Dixon, sp. nov.

PLATE 9, FIGURE 12

Robustum, late dense extensum; habitu et foliis *Rh. tenuifolii*, sed rete *perangustum*, cell. 3–5 μ latis (in *R. tenuifolii* 5–8 μ), inferne *minime laxius;* illo *R. tenuifolii minus pellucidum.* Folia per totam fere ambitum minute denticulatum; folia perichaetialia interna *omnino erecta, madida stricta, brevius acuminata.* Theca *anguste cylindrica*, elongata, suberecta, sicca (deoperculata matura) haud sub ore constricta; operculum *longe subulirostrum.* Fructus *aestate* maturans.

HABITAT: on wood, Mauriceville, Wairarapa, New Zealand, September 26, 1912, *W. Gray 145*; on branches of tree, Mt. Bruce, Wairarapa, 1912 and 1913, *W. Gray 128;* N. E. Valley, Dunedin, *D. Petrie.*

The Australasian species of *Rhynchostegium* are somewhat difficult of elucidation, *R. tenuifolium* (Hedw.) Jaeg. varying considerably in leaf form, areolation, and denticulation, and *R. elusum* (Mitt.) Jaeg. and *R. aristatum* (Hook. f. & Wils.) Jaeg. being much alike in general appearance, and the former seeming to lack very well defined characters. I believe the present however to be a good species, although in general appearance very closely

resembling *R. tenuifolium*, and no doubt easily mistaken for it. The perichaetial bracts in *R. tenuifolium* are however squarrosely spreading with longly acuminate points, while here they are shortly acuminate and the inner ones at least straight and erect. In this respect *R. aristatum* agrees, but that is a smaller, dark green, not glossy plant, having fine, almost piliferous leaf points, and shorter oblong capsule, with a much shorter beak to the lid.

The capsule in the present species is very distinct, but it must be premised that in all the species of the group the capsule if dried before maturity becomes, even if the lid falls off, more or less narrowly cylindrical, curved, and strongly contracted below the mouth, especially on the lower side. Well-ripened capsules, if possible operculate, are necessary to proper study. In *R. tenuifolium* and the two cited species these will be found to be more or less turgid, oblong-elliptical, and usually horizontal, becoming as a rule contracted below the mouth. In the newly described species they are narrowly cylindrical at all stages, very slightly curved and suberect, and except when dried before maturity are very little or not at all constricted below the mouth when dry.

The time of maturing fruit appears also to be different. In *R. tenuifolium* the capsules mature about May–June, and I have specimens from Mr. D. Petrie collected in August with many of the lids still *in situ*. In *R. cylindritheca* on the contrary specimens collected in September show the capsules quite immature, while others gathered in February have the fruits nearly all deoperculate.

It may be noted that there appears to be an error in Flora Tasmaniae, *pl. 176*, where the figures of the perichaetia in *H. aristatum* and *H. collatum* (= *R. tenuifolium*) seem to have been transposed. The bracts in *H. aristatum* are described by Mitten and Wilson as erect, while those of *H. collatum* are described by Wilson as "perich. longius acuminatis, recurvis"; but these characters are exactly reversed in the figures, and I take it there was an accidental transposition of the drawings of the two organs.

NORTHAMPTON, ENGLAND

Explanation of plate 9

FIG. 1. *Dicranoloma angustiflorum* Mitt. (type). *a*, leaf apex, ×20. *b*, cells, lower part of subula, ×200. *c*, perichaetium, ×2.

FIG. 2. *Dicranum aucklandicum* Dixon (type). *a*, leaf, ×10. *b*. upper cells, ×200.

FIG. 3. *Didymodon calycinus* Dixon (type). *a*, lower leaf, ×20. *b*, upper leaf, ×20. *c*, perichaetium, ×10. *d*, upper cells, ×200. *e*, basal cells, ×200.

FIG. 4. *Cinclidotus australis* Dixon (type). *a*, leaf, ×10. *b*, upper cells, ×200. *c*, basal cells, ×200. *d*, marginal cells a little above base, ×200. *e* transverse section of leaf margin near mid-leaf, ×100. *f*, transverse section of leaf margin near base, ×100.

FIG. 5. *Macromitrium prorepens* (Hook.) Schwaegr. (type). *a*, upper cells, ×200.

FIG. 6. *Macromitrium erosulum* Mitt. (Canterbury, *Sinclair & Haast*). *a*, upper cells, ×200.

FIG. 7. *Macromitrium Petriei* Dixon (type). *a*, part of stem, ×1 (left hand branch moist, the rest dry).

FIG. 8. *Pohlia novae-seelandiae* Dixon (type). *a*, leaf, ×20. *b*, upper cells, ×200.

FIG. 9. *Anomobryum densum* Dixon (type). *a*, sterile stem, ×10. *b*, leaf, ×20. *b'*, leaf, flattened out, ×20. *c*, *c'*, fruit, ×2. *d*, upper cells, ×200.

FIG. 10. *Thamnium baculiferum* Dixon (type). *a*, rod-like shoot, ×1. *b*, leaf, ×10. *c*, leaf apex, ×30 (not very accurate).

FIG. 11. *Plerygophyllum distichophylloides* Broth. & Dixon (type). *a*, dorsal, *b*, lateral leaf, ×10. *c*, upper cells, ×200.

FIG. 12. *Rhynchostegium cylindritheca* Dixon (type). *a*, capsules, ×4.

Notes on Baeria and Lasthenia*

HARVEY MONROE HALL

In the North American Flora *Baeria* and *Lasthenia* are treated as distinct genera although only one evident character can be found upon which to maintain their separation. This consists in the fusion of the involucral bracts into a definite cup-like structure in the case of *Lasthenia*, while in *Baeria* the bracts are entirely distinct or at the most only lightly united at the very base. Genera based upon single characters are rarely satisfactory but since in this case the species of each group are more closely related to each other than they are to any species in the other group and since the merging of the two into one, as was once attempted by Dr. Greene† but later abandoned by the same author,‡ would lead to much confusion in the nomenclature, it seems better to retain each as a distinct genus.

BAERIA

The date assigned by most authors for the publication of *Baeria* is 1835. Dr. J. H. Barnhart, to whom I am indebted for much bibliographic assistance, has called my attention to the fact that the signature in which the description appears was passed by the Russian censor on December 25, 1835, and that after making proper allowance for the difference between the Russian (Julian) and Gregorian calendars the actual date of publication must have been after the first of January, 1836. It is certain, however, that *Baeria* was published before *Burrielia*, its oldest synonym, for the part of De Candolle's Prodromus containing the diagnosis of this latter genus did not appear until after the middle of 1836.

With *Lasthenia* eliminated, *Baeria* forms a satisfactory natural

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* This article is supplemental to the treatment of these genera in the North American Flora by the author.

† Man. Bay Reg. 203. 1894.

‡ Fl. Fran. 437. 1897.

genus of five sections, of which all except PLATYCARPHA have been considered, at one time or another, as constituting distinct genera. These will now be discussed seriatim and reasons given for the author's disposal of doubtful species. Field numbers are not cited in this paper since many of the species are so similar in appearance that they are not infrequently mixed on the sheets, even by discriminating collectors.

§ BURRIELIA

Burrielia was described as a genus in 1836 by De Candolle, who recognized three species, the first two of which are forms of the slightly earlier *Baeria chrysostoma* Fisch. & Mey. The third is *B. microglossa* DC., which differs from the true Baerias chiefly in its essentially cylindric involucre and subulate receptacle. *Burrielia leptalea* A. Gray was added in 1865 but was transferred to *Baeria* in the Synoptical Flora in 1884, there having been discovered in the meantime an intermediate species, *Baeria debilis* Greene, which, although much like *B. leptalea*, had a campanulate involucre nearly as broad as in the accepted species of *Baeria*. This again reduced *Burrielia* as accepted by Gray to its third species and left as its chief distinguishing character only the cylindric involucre. On examining the type material of *B. leptalea*, however, I find that the involucres are narrowly turbinate and scarcely wider than in *B. microglassa*. It is thus seen that this involucral character is too variable and indefinite to be of generic value, for which reason I have followed Dr. Greene's treatment and have thrown all of the species here mentioned into *Baeria*, but have retained BURRIELIA as a section because of the subulate receptacle in the three species referred thereto. All other species of *Baeria* possess subglobose or conic receptacles which approach the subulate shape only in starved or depauperate plants.

§ EUBAERIA

My second section comprises the true Baerias. The receptacle is here conic and muriculate; the pubescence is hirsutulous or strigose, never glandular, and the pappus when present consists of mostly uniform paleae or bristles. To this section belongs *B. chrysostoma* Fisch. & Mey., the type of the genus and by far the

most important species both because of its abundance, particularly in California, where thousands of acres of plain and foothill slope are yellow with its bloom each spring, and also because of its richness in forms. The description of a number of these forms as species by earlier botanists was largely the result of attaching undue importance to characters of the pappus. In my Compositae of Southern California* I have attempted to point out the instability of such characters and to arrange some of the forms into natural groupings. Since the type of this species was gathered in the vicinity of Bodega Bay on the coast of Sonoma County (lat. 38° 20′ N.) some have been led to suppose that it was the broad-leaved seacoast form. However, the original description reads: "foliis . . . linearibus integerrimis," and the plate published by the authors of the species eleven years later illustrates a plant with very slender acute leaves. A specimen determined by Meyer and preserved in the Brandegee Herbarium at the University of California is also of the slender upland form. It therefore seems certain that the common form with linear-lanceolate acute leaves and ovate acute involucral bracts is the original *B. chrysostoma* and that the type specimens were collected not on the shores of Bodega Bay but at some locality not under the direct influence of the sea. The broad-leaved form has been described as *B. hirsutula* Greene and since it differs in its broader and roundish somewhat obtuse involucral bracts as well as in its leaves, it may be accepted as a distinct species at least provisionally.

§ PLATYCARPHA

The section PLATYCARPHA forms a natural link between EUBAERIA, with which it agrees in its pappus characters, and DICHAETA, which it closely resembles in habit, but it is unlike either in its smooth campanulate involucre with carinately thickened bracts. There is but a single species, *B. platycarpha* A. Gray, since *B. carnosa* Greene is considered to be an inconstant variant with usually entire leaves and more prominently carinate bracts. There are two sheets of the latter species at the Gray Herbarium, collected by Dr. Greene at Vallejo, April 14 and 16, 1883, and thus presumably a part of the type collection. The

* Univ. Calif. Publ. Bot. 3: 169. 1907.

leaves in these specimens are flat and 1 mm. wide; the bracts have each a strong midrib paralleled by two other ribs exactly as in the type of *B. platycarpha* except that the midrib is slightly more prominent. Although there is some variation in the shape of the involucral bracts, this cannot be correlated with other characters. For example, Dr. Greene's Vallejo plants of *B. carnosa* have bracts with an outline exactly like those of his Byron Springs specimens which have pinnatifid leaves and which must therefore be accepted as *B. platycarpha*.

§ DICHAETA

This section is distinguished from all the preceding by its uniformly dimorphous pappus. However, the achenes are sometimes entirely devoid of pappus in plants which are otherwise exact counterparts of the pappus-bearing forms. It is thus seen that the character of these structures when present is of more importance than their mere presence or absence, a principle which holds in other groups as well. Furthermore, this regular alternation of the two kinds of pappus-scales on a single achene in species of DICHAETA is of much greater significance than are the irregular and fluctuating pappus-forms in some species of EUBAERIA and PTILOMERIS.

B. tenella (Nutt.) Greene is undoubtedly an ecologic form of *B. uliginosa* (Nutt.) A. Gray. Specimens at the Herbarium of the Philadelphia Academy of Sciences, indicated as types by Nuttall, plainly belong to the well-known dwarf form of somewhat gravelly or scarcely alkaline soil, while the more robust and succulent form which represents typical *B. uliginosa* grows on lower and more or less alkaline ground. Slender specimens of *B. Fremontii* have been often labeled *B. tenella*, and this error has led to confusion concerning the proper status of the latter form.

With *B. Fremontii* (Torr.) A. Gray is included not only *B. Burkei* Greene, a form in which the pappus-bristles are reduced to one, but also *Lasthenia conjugens* Greene, the species which at one time led Dr. Greene to unite the two genera. This latter species was originally distinguished by the united bracts of the involucre and the polished olive-green achenes. In the herbarium of the University of California are two specimens of the type collection

and in them the bracts overlap in the usual manner of *B. Fremontii;* only by careful dissection can one demonstrate that they are sometimes lightly joined at the base. In no case do the bracts form a definite cup as in the true Lasthenias. The achenes are as described by Dr. Greene and exactly as in the epappose form of *B. Fremontii.* The association of absence of pappus with glabrousness of the achene is a common phenomenon in *Baeria*, where it occurs in *B. chrysostoma*, *B. hirsutula*, and *B. uliginosa*, as well as in *B. Fremontii.* But that *Lasthenia conjugens* is identical with *B. Fremontii*, or at the most a recent natural segregate, is indicated by the subglobose or dome-shaped strongly hirsute receptacle and hirsutulous as well as glandular tube of the disk-corollas, characters which do not occur in any *Lasthenia* and scarcely even in any *Baeria* except *B. Fremontii.* Since the two are alike in habit and in all other characters the obscure fusion of the involucral bracts cannot be accepted as of specific and much less of generic value.

§ PTILOMERIS

In the section PTILOMERIS, the receptacle is not muriculate, as in all the preceding, but rather scrobiculate, for the achenes are set into small depressions in the receptacle which remain as pits after the achenes have fallen away, or it may be that the individual pedicels have fused with one another so as to present an even surface marked only by the depressions in their summits. This section differs from the others also in the more or less evident glandulosity of the herbage, and the leaves are more inclined to be pinnately parted.

In the North American Flora all hitherto described species of this section are included under *B. aristata* (Nutt.) Coville, in accordance with my reductions in an earlier account where the numerous forms are treated in detail.* This is because they evidently are the result of ecologic conditions or are based upon pappus characters which, from garden experiments and from field observation, have been found to be inconstant. That this reduction might become necessary was anticipated by Asa Gray as

* Univ. Calif. Publ. Bot. 3: 173. 1907.

early as 1859, when he expressed the opinion that all of Nuttall's species of *Ptilomeris* were probably forms of one.*

LASTHENIA

Lasthenia minima Suksd. was originally described as similar to *L. glaberrima* DC., but smaller, the peduncles short, and the inflorescence somewhat pubescent. Specimens of the type collection clearly indicate that it is only a dwarf form of the species with which it was compared. Although the peduncles are lightly puberulent, the involucres are nearly or quite glabrous except on the margins, while the floral and fruiting characters are exactly as in *L. glaberrima*. Specimens are sometimes found which exhibit more or less pubescence on their peduncles and still, because of their robust habit and other characters, are plainly referable to this latter species (e. g., Suisun, May 3, 1892, *Brandegee*). The margins of the involucre are usually if not always somewhat pubescent. The characters upon which *L. minima* rests are thus seen to be inconstant and I have therefore reduced it to *L. glaberrima*.

UNIVERSITY OF CALIFORNIA

* Bot. Mex. Bound. 97. 1859.

Notes on Rosaceae—IX

P. A. Rydberg

DALIBARDA

Dr. Focke includes this genus in *Rubus*, making it a subgenus under the same. In this subgenus, he includes *R. lasiococcus*, *R. Fockeanus*, *R. pedatus* and *R. Gunnianus*. None of these species are related to *Dalibarda repens* L. The latter differs from all species which have been included in *Rubus*, by the practically dry fruit, the essentially monoecious flowers, of which the pistillate ones are apetalous. Dr. Focke describes the flowers as being "both perfect sterile and cleistogamous fruiting." The essentially staminate petaliferous flowers have only rudimentary pistils. The basal apetalous flowers, I think, hardly could be called cleistogamous, as I have found no polleniferous anthers, and think that they are pollinated from the staminate petaliferous flowers. This is something which needs further investigation.

RUBACER

Dr. Greene* restored the generic name *Bossekia* Necker for this genus. It is true that *Rubus odoratus* L. was probably a part of Necker's genus, but *Bossekia* was not properly published under the American Code. The paragraph concerning the publication of generic names reads as follows:

"Canon 10. A generic or subgeneric name is published when it has been printed and distributed: (1) with a generic or specific description (or in paleobotany, a figure) and a binomial specific name; (2) with a generic and specific name and the citation of a previously published description; (3) with a reference to a specific description, which is associable by citation with a previously published binomial species."

As Necker's Elementa does not contain any specific names, *Bossekia* could not have been published under proviso No. 1 or No. 2. It remains to see if it was published under No. 3. Necker

* Leaflets 1: 210 and 230. 1906.

refers to it some simple-leaved species of *Rubus* of Linnaeus, but he does not refer to any special work of Linnaeus. Dr. Greene claims that it was to Species Plantarum, but this is very unlikely. Wherever Necker refers to any work of "Linnaeus," the reference is to the 14th edition of the Systema, which was published six years before Necker's Elementa. This was not a work of Linnaeus, but of Murray. There is in Necker's Elementa under *Bossekia* no "reference to a specific description, which is *associable by citation* with a previously published binomial species." Hence *Bossekia* is not properly published according to the American Code.

Dr. Greene in defending *Bossekia* and attacking *Rubacer* published four pages of sarcastic criticism. Immediately I wrote an article quite as sarcastic in answer, but decided that it was not worth while to publish it, as Dr. Greene's article was an example of either insincerity or hasty carelessness. As example may only be given, Dr. Greene in two places claimed that *Rubacer* meant red maple. A linguist like Dr. Greene knows that the final *r* in *ruber*, red, is a part of the stem of the word and if red maple was meant the word should have been *Rubracer* and not *Rubacer*. Neither did I intend with the name *Rubacer* maple-leaved raspberry, but raspberry maple, which is just as good.

Dr. Greene devotes almost a page to *Rubus moluccanus*, with eight mostly silly questions.* There is no need to answer them in full. Anyone who has access to Rumphius can see from the figure that his *Rubus moluccanus* and his *Rubus moluccanus parvifolius* are not drawn from stages of the same species. Neither were the names given by Rumphius intended to be specific and varietal names as we now apply them. *Rubus parvifolius* L., based on the latter, is not a blackberry but a raspberry related to *R. rosaeflorus*. See Focke.† *Rubus moluccanus*, on the contrary, is a species of the maple-leaved blackberries of Asia of the subgenus *Malacobatus*. Rumphius's figure of *R. moluccanus* shows the plant in fruit. It does not, therefore, represent a seedling state of *R. parvifolius*. Did Dr. Greene investigate these facts before he asked his questions?

Rubus parviflorus Nutt., the earliest name for *Rubacer parvi-*

* See Leaflets 1: 233. 1906.

† Bibl. Bot. 17^{72}: 150. 1911.

florus (Nutt.) Rydb., was a misnomer, for the species has one of the largest flowers found in the whole tribe. Nuttall's specimens from Lake Huron must have had unusually small flowers, and probably Nuttall compared it with *R. odoratus* L., its nearest relative, but the specific name *parviflorus* was under all circumstances an unhappy selection. *Rubus nutkanus* Moc. is the name which has usually been applied to this species. It may, however, belong to *Rubacer tomentosus*, which is perhaps more common on the Nootka Sound. There is little to say about the other synonyms given under this species, except *Rubus Roezli* Regel, which does not belong here but to *Oreobatus deliciosus*, as the figure in Gartenflora shows.

Heller took up the name *Rubacer velutinus* for *R. tomentosus* Rydb., which he based on *R. velutinus* Hook., an untenable name, being preoccupied by *R. velutinus* Vest.

OREOBATUS

This name was not based on the subgeneric name *Orobatus* Focke (meaning the same, but not properly formed) as I had overlooked the same, but this fact does not invalidate it as a generic name.

Dr. Otto Kuntze reduces the whole genus to varieties of *Rubus odoratus* L. It shows how superficial he was, paying in this case attention only to leaf-forms and not to the structure of the flower and fruit. Professor A. Nelson fell into the same error, but in less degree, when he made *Oreobatus deliciosus* a species of *Bossekia*. There are only two alternatives in this case. Either *Oreobatus* and *Rubacer* (*Bossekia*) must be regarded as distinct genera or else both retained in *Rubus*.

Oreobatus neomexicanus (A. Gray) Rydb. (*Rubus neomexicanus* A. Gray) has often been regarded as a variety or even as a synonym of *O. deliciosus*. I think, however, that it is well distinct.

Oreobatus rubicundus was lately described by Wooton and Standley. It is closely related to *O. neomexicanus*, but has smaller leaves, flowers and fruit, and nearly glabrous leaves. The pubescence on the petioles is appressed. I have seen no specimens of this except those cited in the original publication.

Oreobatus trilobus (Seringe) Rydb. is a fourth species of the genus. The variety *Rubus trilobus guatemalensis* Focke is of little value. The characters given are not distinctive. The shorter terminal lobe of the leaves is only occasional and found only rarely even in specimens from Guatemala, and the color of the petals, as far as I have been able to find, is always purple.

CHIAPAS: *Ghiesbreght, 97, 509.*

OAXACA: Sierra Filipe, *Pringle 4670; Liebmann; E. W. Nelson 1172;* 18 miles southwest of the city of Oaxaca, *Nelson 1413.*

VERA CRUZ: Orizaba, *Seaton 252.*

PUEBLA: Boca del Monte, *Purpus 2453.*

GUATEMALA: Volcan d'Agua, *Maxon & Hay 3676, 3744; Pittier 32; Shannon 3631.*

RUBUS

LIMITATION OF THE GENUS AND SYNONYMS

The only two botanists who have tried to divide *Rubus* into several genera are Rafinesque and Greene. Some of the proposed genera are habitually fairly distinct, but there are no essential differentiations in the flower and fruit, on which generic lines could be based. Some of the Asiatic and South American species may represent distinct genera, but, as far as the North American (and also European) species are concerned, there is none that in my mind is different enough from the general type to make its separation as a genus warranted, except those removed to *Dalibarda*, *Rubacer*, and *Oreobatus*.

Cylactis was the first genus proposed by Rafinesque. Its type was *Cylactis lyncimontana* or *C. montana* Raf., which is the same as *Rubus pubescens* Raf., *R. triflorus* Richards, and *R. americanus* (Pers.) Britton. This is a raspberry as far as the flowers (except the filament) are concerned. The fruit approaches the raspberries in color and flavor, but does not separate as a cap or thimble. It is a dewberry as to the habit, but the receptacle is not fleshy. It differs from both dewberries and raspberries in the wholly unarmed plant, the broad and almost free stipules, and the dilated filaments, three-toothed at the apex, the longer middle tooth bearing the anther. The lack of armature (prickles or bristles) is no generic character, for both the closely related

R. saxatilis and *R. transmontanus* are more or less bristly. Neither is the width of the stipules. The structure of the filaments separates the species of the *R. arcticus* and *R. saxatilis* groups from all other American species of *Rubus*, but in *R. saxatilis* and *R. transmontanus* this character is less marked. The latter connects the group with the raspberries, the former with the dewberries of Europe.

Dyctisperma, *Cumbata*, and *Ametron* of Rafinesque were based on Asiatic species usually regarded as blackberries and naturally will not be discussed here.

Ampomele Raf. was based on an Asiatic raspberry.

Selnorition Raf. was based on American and European dewberries including also *R. saxatilis*. It has no generic value.

Manteia Raf. was based on *Rubus stellatus*, a species which is, notwithstanding its merely lobed leaves, so closely related to *R. acaulis* with three-foliolate leaves that many botanists regard them as belonging to the same species. The structure of the fruit and the flowers is identical. The latter apparently grades into *R. arcticus*, which on the other hand connects with *R. pubescens*. These species are also connected by hybrids. *Manteia* could not be regarded as a distinct genus from *Cylactis*.

Batidaea (Dumort.) Greene was based on the red raspberries with *R. idaeus* as the type. If we had no other species of *Rubus* than the raspberries and the blackberries, I would be willing to accept this genus. As stated above, *R. pubescens* combines characters of the raspberries and dewberries (= decumbent blackberries), but there are Mexican species of *Rubus*, as for instance *R. scandens* and *R. fagifolius*, which are blackberries in every respect except the fruit. The receptacle is practically dry and the drupelets fall off separately. So they do also in a West Indian blackberry, *R. jamaicensis*. In some Asiatic species, usually regarded as raspberries, the fruit does not "come off as a thimble." *Rubus ellipticus* is so like a Mexican group of blackberries in both habit and flowers that anyone not knowing its raspberry fruit would place it in that group and next to *R. adenotrichos*.

It is, therefore, impossible to draw a line between blackberries and raspberries, which also hybridize not seldom in Europe.

As far as I can interpret the American Code, the type of

Rubus with Linnaeus should be *R. idaeus*, and if I had separated the raspberries and blackberries generically, I would have adopted *Rubus* as the generic name of the former. Dr. Greene does not accept the Linnaeus Species Plantarum as the starting point of botanical nomenclature, and on that ground probably had valid reasons for a different interpretation. The validity of the proposed species of *Batidaea* I shall discuss later.

Melanobatus Greene has no foundation as a genus separate from *Batidaea*. The only characters given by Greene distinguishing the two genera are the pulp of the fruit and the reticulation of the pyrenes. The former is said to be soft, very juicy and perishable in *Batidaea* and scanty, firm rather than watery, in *Melanobatus*. *Rubus idaeus aculeatissimus* of Siberia according to Focke has almost dry fruit. Regarding the keel on the back of the putamen, it is not very prominent in *R. leucodermis* and not found at all in *R. Pringlei* Rydb. (*R. occidentalis grandiflorus* Focke). The leaves are said to be "pinnately (rarely pedately) 3–5-foliate." As far as I know, whenever the leaflets are more than three in the black raspberries, the leaves are pedately compound with the terminal leaflet long-petioluled. Someone may ask the question if this also applies to *Melanobatus neglectus* (Peck) Greene and *Melanobatus michiganus* Greene. No, not always, but these I understand as forms of *R. occidentalis* × *strigosus*,* and the occasional pinnately five-foliolate leaves are an inheritance from the other parent, *R. strigosus*.

Paramena Greene has *R. spectabilis* Pursh for the type. This can not be separated generically from the other raspberries. It is closely related to *R. rosaefolius*, although this relationship has not been pointed out so far as I know. There are all kinds of gradations between the *R. rosaefolius* group and the *R. idaeus* group.

Cardiobatus Greene was based on *Rubus nivalis* Dougl. No character of generic value has been pointed out by Dr. Greene. He himself stated: "Technically, a true blackberry" [I do not know if it has a fleshy receptacle, but I doubt it]. The best character to separate it from the dewberries is the broad, almost

* The hybridity of *R. neglectus* is satisfactorily proven, as the hybrid has been produced artificially and does not differ from the wild plant.

free stipules. Greene describes the petals as rose-red, showy. As far as I have been able to find they are white.

Psychrobatia Greene was based on *Rubus pedatus* Smith. This is the best of the genera proposed by Dr. Greene. The pedately compound leaves are a striking character, but known in many blackberries and the black raspberries. The statement made by Dr. Greene, that only two carpels mature, is erroneous, for there are usually more than two, although always few. They are large and as far as I understand substipitate, i. e., tapering at the base, a character not found in any other species; but I have not thought it important enough to give the plant generic rank.

Comarobatia Greene was based on *Rubus lasiococcus* A. Gray. The habit is that of *R. pedatus* and other unarmed species, the leaves like those of *R. stellatus* for which it had been mistaken. The fruit is that of a dewberry, although the drupelets are few and pubescent; but pubescent fruit we find in the raspberries, in *Rubus ursinus* and some of its relatives, and in many Mexican species of blackberries.

Greene also restores the pre-Linnaean genus *Chamaemorus* Clusius. At first glance this seems a fairly good genus, but the habit is that of the *R. arcticus* group, especially *R. stellatus*, which also has simple leaves. *Rubus Chamaemorus* is a dioecious plant. All the species of the *R. arcticus* group have a tendency to be polygamo-dioecious. In the structure of the fruit and the stipules, there is little difference. In the broad spreading petals and not dilated filaments it differs, however, but in this respect it agrees with most blackberries.

Greene admits two species, *Chamaemorus anglica* and *C. norwegica*, both credited to Clusius; but Clusius did not have these names in the form given. The first is found only in the margin opposite a fictitious illustration under the name *C. anglicana*, and the latter is spelled in the heading *Chamaemorus norwagica* and in the margin as *C. Norwagica*. Such a way of citation is careless; but Dr. Greene may claim that he intended an improvement of form and spelling, as *anglica* is a better and more common form than *anglicana* and an *e* in the second syllable of *norwegica* is better than an *a*. But why not make the improvement complete and spell the latter with a *v* instead of a *w*, as the latter character was unknown to Latin?

None of these genera I regard as distinct enough from *Rubus* proper to retain their generic rank.

GROUPS AND SPECIES OF RUBUS

CHAMAEMORI

This contains only one species, *R. Chamaemorus* L. The figure of *Chamaemorus anglicana* in Clusius' Historia is fictitious. No such plant is found in England. See further notes above under *Chamaemorus*.

LASIOCOCCI

As far as I know this group is also monotypic, the species being *R. lasiococcus* A. Gray. It is the same as the genus *Comarobatia* Greene [see above], and a part of Focke's subgenus *Dalibarda*.

PEDATI

This contains only one species, *R. pedatus*, unless *R. Fockeanus* and *R. Gunnianus* of China and Tasmania might be referred here. It is also a part of Focke's subgenus *Dalibarda* and the genus *Psychrobatia* Greene.

ARCTICI

This consists of *R. stellatus*, *R. acaulis*, and *R. arcticus*. It is the same as the series *Arctici* of Focke's subgenus *Cylactis*, and the genus *Manteia* Raf.

Rubus stellatus Smith. Except as to the three-lobed instead of three-foliolate leaves there is little difference between this species and *R. acaulis*. If the latter should be united with *R. arcticus*, I see no reason why *R. stellatus* should not be included there also.

Rubus acaulis Michx. and *R. arcticus* L. Most of the American material labeled *R. arcticus* L. belongs to *R. acaulis*. It is also the same as *R. pistillatus* Smith. Smith stated that he had seen it and *R. arcticus* cultivated together and that they remained distinct. Seringe also regarded them as distinct. *Rubus acaulis* is found neither in Europe nor in Asia except in the extreme eastern part, and *R. arcticus* is not found on the North American arctic coast or in Alaska. It is in the region where both are found, viz., in Labrador, Quebec, and apparently also the Canadian Rockies, where there is some trouble in distinguishing them, on account of intermediate forms. May these not be hybrids?

SAXATILES

Rubus saxatilis L. No authentic specimens of this have been collected on the North American continent, but on this side of the Atlantic Ocean it is found only in southern Greenland. A sterile branch that may belong here was collected by Bicknell at Piedmont, Quebec.

Rubus pubescens Raf. seems to be the oldest specific name for the species usually known as *R. triflorus* Richardson or *R. americanus* (Pers.) Britton. Rafinesque based his species on *Rubus saxatilis canadensis* Michx. Evidently he did not know the plant, for eight years later he proposed a new genus based on what he supposed to be a new discovery of his. In the same year, 1819, the species was published both as *Cylactis lyncemontana* and *C. montana*. Seringe also thought there were two distinct species. His *R. mucronatus* is the same as *R. pubescens* Raf. and *R. aegopodioides* was based on *Cylactis montana* Raf. Torrey adopted Michaux's varietal name as specific and Britton did the same with that of Persoon, but both *Rubus canadensis* and *R. americanus* had been used previously.

Rubus transmontanus Focke. Focke proposed this name, as he thought, instead of the untenable *R. hesperius* Piper, but his description does not fit the latter at all. *R. hesperius* is a black raspberry, closely related to *R. occidentalis*, but the leaves are without tomentum beneath. The stem is armed with curved prickles as in that species. The plant described by Focke is, from the description, closely related to *R. pubescens*, but the stem is more or less prickly or bristly. The specimen cited below is the only one seen which fits the description. This may be a hybrid between *R. pubescens* and some species of the *R. strigosus* relatives. Focke gives as distribution, eastern Washington and the banks of the Columbia River at Revelstoke, British Columbia. The first part of the range may have been taken from the actual *R. hesperius* Piper, and the specimens which Focke described were probably from Revelstoke.

BRITISH COLUMBIA: near mouth of Dowrie Creek, 1905, *Shaw 1117*.

GLABRATI

This group comprises the subgenera *Chamaebatus* and *Orobatus* of Focke, which I can not separate, the former comprising the more

dwarf and simple-leaved species; but many of the *Orobati* have also simple leaves, and *R. pumilis* has sometimes three-foliolate ones. The species mentioned is the type of Greene's genus *Cardiobatus.*

Rubus pumilus Focke must be a very local species. The only specimens I have seen (the type has not been available) are the following:

MEXICO: Ixtaccituatle, 1903, *Purpus 241.*

CHIHUAHUA: Mt. Mohinora, 1898, *Nelson 4863.*

Rubus nivalis Dougl. Mr. J. M. Macoun thought that the descriptions of this species in Hooker's Flora Boreali-Ameircana and in Howell's Flora of Northwestern America did not apply to the same species and substituted the name *R. pacificus* for the latter. I can not see why Howell's description does not apply to *R. nivalis* Dougl. Focke has the same idea of *R. nivalis* Dougl. as myself.

Rubus glabratus H.B.K. This species of wide distribution in the Andes of South America has been reported from Costa Rica (*Pittier 167*); but I have seen no specimens from there, neither had Dr. Focke.

ROSAEFOLII

This group comprises the *Spectabiles*, *Rosaefolii*, and perhaps some other sections of Focke's subgenus *Idaeobatus*. The *Spectabiles* constitute the Greenean genus *Paramena* as originally constituted, but its author on some subsequent pages extended the genus to include simple-leaved species of the section *Corchorifolii* of Focke.

Rubus spectabilis Pursh. This is usually described as being unarmed. Occasionally, however, it has a few small straight prickles. Prickles are more common in the next species.

Rubus franciscanus Rydb. This has been mistaken for *R. Menziesii* Hook., which, however, is the same as *R. ursinus*, as pointed out by Dr. Focke. This mistake depended perhaps on the suggestion made in Hooker's Flora that the petals were probably red. Watson, therefore, named the present species *R. spectabilis Menziesii* and Greene included it in *Parmena* under the name *P. Menziesii.*

Rubus rosaefolius has been collected growing spontaneously

on several of the West Indian islands, such as Guadeloupe, St. Kitts, and Porto Rico.

IDAEI

This group consists of the section *Idaeanthi* of Focke's subgenus *Eubatus* and Greene's genera *Melanobatus* and *Batidaea*. Greene admitted seven species of the former and eighteen species of the latter, if *Rubus idaeus*, which he evidently regarded as the type but did not name under *Batidaea*, is counted. It is impossible for me to follow him in the segregation of these species of *Batidaea*. Many of them are based on only occasional or abnormal forms or mere individual variation. Except two of his species of *Batidaea* (viz., *B. arizonica* and *B. Itascica*) and *Rubus idaeus*, they may all be regarded as geographical varieties or subspecies of *R. strigosus*. *Batidaea arizonica* Greene is the best of all the species proposed and, in whatever way the others may be treated, this I think should under all circumstances be regarded as a distinct species. *Batidaea Itascica* Greene was based on one single specimen which I can but refer to the European *Rubus idaeus*, which is escaped in this country. See further remarks under the different species of the group.

Rubus phoenicolasius Maxim. This is in cultivation and has been naturalized in the eastern States. It is distinguished from our native species in the densely red-bristly stem and the small red incurved petals. The following specimens have been seen:

NEW YORK: Spuyten Duyvil, *Rydberg*.

NEW JERSEY: Little Silver, 1890, *Lorett;* Atlantic Highlands, 1906, *Britton & Hollick*.

CONNECTICUT: Fairfield, *Eames 5532*.

DISTRICT OF COLUMBIA: Eckington, 1897, *Irwin*.

PENNSYLVANIA: Lancaster County, 1911, *Carter*.

Rubus ellipticus Smith. This is also in cultivation in warmer parts of North America and has established itself in the West Indies. If it were not for the yellow fruit, which comes off as a thimble, this species would be included in the *Adenotrichi* group of blackberries. To this belongs the following specimen:

JAMAICA: Cinchona, 1905, *Harris 9131*.

Rubus glaucus Benth. This was originally described from Ecuador, but has since been found in Colombia and Costa Rica.

Specimens which I refer here rather than to *R. eriocarpus* have been collected in Mexico. These are not typical and may represent a distinct species, closer, however, to *R. glaucus* than to *R. eriocarpus*.

COSTA RICA: Buena Vista, 1903, *Cook & Doyle 36;* 1874, *O. Kuntze.*

GUATEMALA: Tres Cruces, 1889, *John Donnell Smith 1622.*

Specimens collected near Cuernavaca, State of Morales, Mexico, by Rose and Hough are remarkable, not only for the station at which they were collected, this being much further north than the formerly known range extended, but also for the large size of the leaves, the leaflets of some of the leaves of the stem being up to 15 cm. long, and for the more glandular pedicels.

MORELOS: Cuernavaca, May 27–30, 1899, *Rose & Hough 4410, 4414.*

Rubus eriocarpus Liebm. This as well as the preceding has been determined as *R. occidentalis*, which is not found in any part of Mexico or Central America. All so named belong to one of the three species of *R. glaucus*, *R. eriocarpus*, or *R. Pringlei*. The following specimens belong to *R. eriocarpus:*

VERA CRUZ: Vera Cruz, 1901, *Rose & Hay 6183;* San Miguel del Soldado, 1899, *Pringle 8113;* Jalapa, 1899, *Rose & Hough.*

OAXACA: Chinantla, *Liebman 1692.*

PANAMA: El Boquette, 1911, *Pittier 3135.*

Rubus Pringlei Rydb. This has also been confused with *R. occidentalis*. Focke in 1891 described it as var. *grandiflora*, but twenty years later, having evidently forgotten its first name, redescribed it as var. *mexicana*. It is evidently the same as described in 1839 by Schlechtendal as var. *incisus*, but neither of these varietal names could be used as specific. Therefore, I took the pleasure of naming the species after Mr. C. G. Pringle, who has collected the best specimens of this I have seen.

HIDALGO: Pachuca, 1899, *Rose & Hough 4463;* 1901, *Rose & Hay 5553.*

OAXACA: Sierra de San Felipe, *Pringle 4686;* Salazar, 1903, *Rose & Painter 7008.*

MEXICO: between Toluca and Mexico City, June 28, 1910, *Rusby 317.*

Rubus occidentalis L. This is confined to the United States and Canada, east of the Rocky Mountains. Specimens from the west which have been referred to *R. occidentalis* belong to *R. leucodermis* Dougl., *R. glaucifolius* Kellogg, or *R. bernardinus* (Greene) Rydb. This was made the type of the genus *Melanobatus* Greene.

Rubus leucodermis Dougl. *Melanobatus leucodermis* Greene. This takes the place of *R. occidentalis* west of the Rockies from British Columbia and Montana to Utah and central California. In southern California its place is taken by *R. bernardinus*.

Rubus glaucifolius Kellogg. Kellogg's specific name was adopted by Dr. Greene under *Melanobatus*, but the only specimens seen labeled *M. glaucifolius* in Greene's handwriting are in his private herbarium and were collected by himself at Eureka, Siskiyou County. These specimens belong to *R. leucodermis*. *R. occidentalis* and *R. leucodermis* are never glandular, while *R. glaucifolius* and *R. bernardinus* are so in the inflorescence. The following specimens belong here.

CALIFORNIA: Mt. Sanedrin, Lake County, 1902, *Heller 6040;* Emigrant Gap, 1882, *M. E. Jones, 3309;* Forest Ranch 1896, *Mrs. Austin 113;* Mt. Pleasant, Spanish Peak Range, 1909, *Leiberg 5161*.

OREGON: Rabbit Ears, south slope of Umpagre Divide, *Applegate 2643*.

Rubus bernardinus (Greene) Rydb., *Melanobatus bernardinus* Greene. This is closely related to *R. glaucifolius* and perhaps not specifically distinct. Its range is, however, much more southern. Rusby's specimens from New Mexico are referred here doubtfully. They are from a locality so far from the known range of the species and no specimens of a black raspberry have been found anywhere between Southern California and Rusby's station. To *R. bernardinus* belong:

CALIFORNIA: San Bernardino Mountains, 1901, *Parish 5046;* Strains Camp, Los Angeles County, 1902, *Abrams 2584;* Los Angeles County, 1899, *Chamberlain*.

NEW MEXICO: Mogollon Mountains, July 15, 1881, *Rusby 123*.

Rubus nigerrimus (Greene) Rydb. This was originally described as *R. hesperius* by Piper. As that name was pre-

occupied, Focke in 1911, substituted *R. transmontanus*, but misapplied the name to another species related to *R. pubescens*. In the meantime Dr. Greene had named it *Melanobatus nigerrimus*.* It is more closely related to the eastern *R. occidentalis* than to the western *R. leucodermis*, but differs from both in the lack of tomentum. The following specimens have been seen:

WASHINGTON: Wawawai, 1894, *Piper 1788;* 1897, *Piper;* Alamota, 1894, *Piper 1553;* damp woods, Columbia River, West Kickitat County, 1883, *Suksdorf* (both in flowers and fruit).

Rubus idaeus L. This European species is sometimes cultivated in this country and has occasionally established itself. It has not a trace of glandular bristles. The inflorescence has small weak prickles, sometimes bristle-like but never gland-bearing. In cultivation forms are found with the habit of *R. idaeus* with a few glandular hairs, but these forms are to be regarded as hybrids between it and *R. strigosus*. *Batidaea Itascica* Greene is evidently a synonym of this species. The following specimens belong here:

NEW YORK: 1879, *L. F. Ward.*

WASHINGTON: Watesburg, 1897, *Horner 160.*

MINNESOTA: Lake Itasca, *Sandberg 1173* (type of *Batidaea Itascica* Greene).

CONNECTICUT: Bridgeport, *Eames 5053a.*

NORTH DAKOTA: Minot, 1907, *Lunell.*

Rubus melanotrachys Focke. This was described seventeen years ago by Focke. In the same article he treats it both as a species and as a subspecies of *R. idaeus*. Of all the North American forms this is closest to *R. idaeus*, being non-glandular, but the young branches, petioles and inflorescence are sparingly pilose or glabrate, instead of finely tomentose. The only specimen seen by me is the following, which has been referred to *R. idaeus* by Fernald.†

IDAHO: Cedar Mountain, Latah County, *Piper 2879.*

Rubus arizonicus (Greene) Rydb. (*Batidaea arizonica* Greene).

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* The other two species of *Melanobatus* of Greene, viz., *M. neglectus* and *M. michiganus*, are based on a hybrid, *R. occidentalis* ×*strigosus* (*R. neglectus* Peck), the former being the more common form, resembling most one parent, *R. occidentalis*, while the latter represents the form more like *R. strigosus*.

† See Rhodora 2: 198. 1900.

This is the best species of *Batidaea* proposed by Greene. It is characterized by the toothing of the leaves and by the fact that the leaves of the floral branches are usually pinnately 5-foliolate, while in all the other species they are, as a rule, 3-foliolate or simple.

ARIZONA: Fly Peak, *Blumer 1260; Jones 6056d;* San Francisco Mountains, *MacDougal 258, 373; Toumey 116; Pearson 329; Coville 1125, 1054; Wooton; Leiberg 5756;* Santa Catalina Mountains, *Livingston & Thornber;* Huachuca Mountains, *Goodding 145, 325.*

NEW MEXICO: *Standley 7705, 6707, 6138; Goldman 1672, 1598;* Mogollon Mountains, *Metcalfe 373;* Hillsboro Peak, Black Range, *Metcalfe 1202;* Chloride, 1909, *Goldman 1759;* Capitan Mountains, 1903, *Grant 76;* Winsor's Ranch, 1908, *Standley 4090.*

CHIHUAHUA: Colonia Garcia, *Townsend & Barber 87.*

Rubus strigosus Michx. To my mind there is no doubt that this species is specifically distinct from *R. idaeus* L. Fernald in discussing the occurrence of *R. idaeus anomalus* Arrh. in America* treated also of the relationship of *R. strigosus* and *R. idaeus* and made the statement: "Upon this character—the presence or absence of glands—rests the separation of the American *Rubus strigosus* and the European *R. idaeus*." While this is the most striking difference, it is not the only one. *R. idaeus* never has glands, *R. strigosus* is exceedingly rarely, if ever, without some trace of glands of some kind. The prickles in the inflorescence and on the petioles of *R. idaeus*, although weak, nearly always are somewhat flattened and slightly curved. This is never the case in *R. strigosus*. If the latter is without glands, it is without prickles and bristles. In *Rubus idaeus* the young stems, rachis and petioles of the leaves, peduncles and pedicels are more or less finely tomentulose. This is not the case in the typical eastern *R. strigosus*. In the high northern plant (*Batidaea subarctica* Greene), which has been included in *R. strigosus*, the inflorescence is pubsecent but not of the fine character found in *R. strigosus*. Fernald claims that the American plant sometimes is without glands, and cites two specimens, *John Macoun 4550* and *Rydberg 657*. I have not seen the former, but there are specimens of

* Rhodora 2: 195–200. 1900.

the latter in the herbarium of Columbia University, in that of the New York Botanical Garden, and in the United States National Herbarium. All these specimens are apparently glandless, but a closer examination shows there are some minute glands, mostly sessile, both on the pedicels and the hypanthium. They represent a rather abnormal form belonging to the western so-called *R. strigosus*, i. e., *R. melanolasius* Focke, and constitute the type of *Batidaea dacotica* Greene. Fernald also cites *Piper 2879* as a specimen also approaching *R. idaeus*. This number belongs to *Rubus melanotrachys* Focke. Fernald evidently overlooked the difference in the pubescence of the inflorescence, which is pilose instead of tomentulose. He also stated: "Often, too, shrubs growing in shade show a strong tendency to lose not only the glands of the calyx, but the white pubescence ordinarily characteristic of the leaves." This is perfectly true and in both *R. idaeus* and *R. strigosus* the leaves are sometimes almost without tomentum. The two specimens cited, however, were a somewhat unfortunate selection, for both *Piper 2268* and *Sandberg, MacDougal & Heller 259*, belong to *Batidaea peramoena* Greene, which should be separated from *R. strigosus*, at least as a variety. The sepals are of a different shape, much narrower than in the eastern *R. strigosus*. No typical *R. strigosus* with rather firm rugose leaves, dark green above, is found in the Rockies or west thereof. All the following species may be regarded by conservative botanists as varieties of *Rubus strigosus*, though this as well as *R. arizonicus* and *R. melanotrachys* must be regarded as distinct from *R. idaeus*. Robinson and Fernald in the New Gray's Manual adopt the name *Rubus idaeus aculeatissimus* Regel & Tiling for *R. strigosus* Michx., which was unwarranted, for Regel and Tiling's variety is the same as *R. sachalinensis* Lev.,* a species or subspecies with almost dry fruit and limited to eastern Asia.

Batidaea heterodoxa Greene is but a form of *R. strigosus*, and one that is not uncommon with the upper leaves, simple and three-lobed. It has nothing to do with *Rubus Egglestonii* Blanchard or what Fernald regarded as *R. idaeus anomalus* Fries, of which it is given as a synonym in Gray's New Manual. *Batidaea elegantula* Greene is in my opinion a rather typical *R. strigosus*, while *B.*

* See Focke, Bibl. Bot. 17[72]: 210. 1911.

amplissima Greene is a shade-form with coarser teeth and in age practically no tomentum on the lower surface of the leaves. The younger leaves of the type specimen, however, are tomentose beneath.

Rubus melanolasius Focke is the Rocky Mountain representative of *R. strigosus*. If it should be treated as a species or a geographical variety of *R. strigosus* is questionable. It is low in stature, much more bristly and glandular, some of the bristles are often stout, prickle-like, and more or less flattened but straight; the leaves are thinner, light green above, the sepals are shorter and broader, and the fruit is much more acid. It is rather variable. *Batidaea Sandbergii* is the typical form; *B. laetissima* Greene, a paler plant with light green foliage, from exposed situations in Colorado; *B. dacotica* Greene, a nearly glandless form, and *B. unicolor*, a shade form almost without tomentum on the lower surface of the leaves; none of them worth even a varietal name, scarcely worth mentioning as a form.

Rubus acalyphaceus (Greene) Rydb. This was based on *Batidaea acalyphacea* Greene. It is very problematic if this should be regarded as distinct from the last species as the only difference is the pubescent stems. If it were not for the fact that these pubescent specimens are found in only a part of the range of *R. melanolasius*, I should have regarded *B. acalyphacea* as another synonym of that species. *Batidaea subcordata* Greene is the more common form of the same. It is the more appropriate name of the species and represents the normal form, and would have been used if the name *B. acalyphacea* had not had page priority.

Batidaea cataphracta Greene is intermediate between *B. acalyphacea* and *B. subcordata* but depauperate and densely white tomentose on the lower surface of the leaves. *B. filipendula* Greene is a light-colored form, depauperate, with more slender pedicels.

WYOMING: Silver Gate, Yellowstone Park, 1900, *Mearns 2353;* Lower Golden Gate, *Mearns 2553;* Leucite Hills, 1901, *Merrill & Wilcox 677.*

UTAH: Dyer Mine, 1902, *Goodding 1260.*

NEVADA: Clover Mountains, 1908, *Heller 9232.*

IDAHO: Trinity Lake region, 1910, *Macbride 659.*

Rubus peramoenus (Greene) Rydb., based on *Batidaea peramoena* Greene, differs from *R. melanolasius* in the more slender habit, in the less numerous bristles, but above all in the narrower, gradually long-acuminate sepals. The leaves are thin, almost without tomentum beneath. It is represented by specimens from

IDAHO: *Leiberg 1105; Sandberg, MacDougal & Heller 259.*

MONTANA: *Kirkwood & MacDougal 263, 264.*

OREGON: *Brown 85, 88; Cusick 1729; Sheldon 8161.*

WASHINGTON: Spokane, *Piper 2268.*

BRITISH COLUMBIA: *Dawson 7040.*

Rubus viburnifolius (Greene) Rydb., *Batidaea viburnifolia* Greene, differs from the last only in being lower, densely bristly, leaves strongly plicate and strongly veined. It therefore stands nearer *R. melanolasius* than *R. peramoenus* does, but it has the narrow sepals of the latter species. It may be a high mountain and subarctic form of *R. peramoenus.*

The following specimens belong here:

BRITISH COLUMBIA: Glazier, 1909, *Rusby;* Similkameen River, *J. M. Macoun 69970;* Emerald Lake, *Shaw 136;* Roger's Pass, 1904, *Shaw 472.*

ALASKA: Lake Illiamna region, 1902, *Gorman 26;* Rampart, 1901, *Jones 44, 36;* Kenai, 1901, *Nielson 47;* Yukon River, 1903, *Hollick.*

YUKON: fifty miles above Stuart River, 1899, *Gorman 1093;* Hunter Creek, *John Macoun 58470;* Dawson, *Williams 1; Tarleton 162b.*

MONTANA: Gallatin River, 1905, *Blankinship 163;* Midvale, *Umbach 373.*

ALBERTA: base of Tunnel Mountain, 1897, *McCalla 2096;* Lake Louise, *J. M. Macoun 65104.*

Rubus subarcticus (Greene) Rydb., *Batidaea subarctica* Greene. Most of the high northern specimens of what have been called *R. strigosus* have more or less pubescence on the inflorescence and young parts of the stem and branches; the stem is also much more glandular-bristly, and the sepals broader, shorter and more abruptly acuminate. If these forms should be separate from *R. strigosus* or not is hard to tell. I hesitated for a long time in giving them a name, but I found that they grew commonly in

Alaska and Yukon, and that *Batidaea subarctica* Greene was based upon them. I therefore admitted this as a questionable species. It is probably the same as *Rubus idaeus canadensis* Richards. Numerous specimens have been seen from Alaska, Yukon, and Athabasca, where it is the common species. The following eastern specimens also belong here:

NEWFOUNDLAND: 1894, *Robinson & Schrenk; Waghorne; Howe & Lang 919; Sornberger 223;* St. Johns, *Williamson 814.*

LABRADOR: Lanse au Clair, 1894, *Waghorne.*

ST. PIERRE: Bois Brulé, *Arsène.*

QUEBEC: Seven Islands, *C. B. Robinson 864;* Bic, *Williamson 1217.*

NOVA SCOTIA: Yarmouth, *Howe & Lang 71.*

MICHIGAN: Houghton, 1893, *Ely.*

MINNESOTA: Duluth, *Rydberg 8305.*

Rubus carolinianus Rydb. All the specimens referred to *R. strigosus* from the mountains of North Carolina differ from the ordinary *R. strigosus* of the northern states in the densely retrorsely glandular hispid and also puberulent stem. Besides, I have seen no specimens whatever of any red raspberry from any station between northern Virginia and the mountains of North Carolina. *R. carolinianus* may be nothing more than a geographical variety of *R. strigosus*, but as it evidently stands in the same relation to it as *R. melanolasius*, *R. peramoenus*, *R. viburnifolius*, and *R. subarcticus*, I admitted it as a species in the North American Flora.

NORTH CAROLINA: Mt. Mitchell, 1897, *Biltmore Herbarium 5685;* Black Mountain, 1853, *Gibbes;* Andrews Bold, Great Smoky Mountains, *Beardslee & Kofoid.*

Rubus Egglestonii Blanchard. This was first recorded as *R. idaeus anomalus* Arrh. by Fernald,* but it is not the same as the European plant. Mr. Blanchard† points out that it stands in somewhat the same relation to *R. strigosus* that var. *anomalus* does to *R. idaeus*, glandular hairs being present in *R. strigosus* and *R. Egglestonii*, but absent in *R. idaeus* and the var. *anomalus*. The latter is closely related to *R. idaeus*, differing in no respect from *R. idaeus* except in the usually simple, entire or lobed and rounded

* Rhodora 2: 195. 1900.

† Torreya 7: 140. 1907.

leaves (or leaflets if the leaf happens to be compound, which is seldom the case). *Rubus Egglestonii* differs more from *R. strigosus*, viz., in the elliptic, obtuse, merely mucronate sepals, the slender habit, and small leaves. In my opinion, it is a distinct species, perhaps derived from *R. strigosus*, or perhaps a hybrid between the latter and *Dalibarda repens* L. The rarity of well-developed fruit and the poorly developed pistils would suggest hybrid origin. Botanists who have the chance of seeing it in the field are urged to follow up this suggestion.

URTICIFOLII

Rubus trichomallus Schlecht. This has been merged into *R. urticifolius* and Dr. Focke still regards it as synonymous with that species, but I think that it should be held distinct. The South American plant has a compact inflorescence and ovate sepals, which are soon reflexed. The Mexican and Central American plants on the contrary have a looser inflorescence, ovate, lanceolate sepals, closing around the young fruit, and only in age becoming spreading. The following specimens belong to *R. trichomallus:*

COSTA RICA: Santiago (east of Cartago), April 20, 1906, *Maxon 81;* Vulcan Irazu, June 1874, *O. Kuntze* (labeled *R. costaricanus*); Turrialva, June 21, 1874, *O. Kuntze 2245*.

Rubus ferrugineus Wikst. This seems to have been a lost species. However, it has been collected again on the same island from which it was originally described, viz., Guadeloupe, but it has been mistaken for *R. jamaicensis*, from which it is easily distinguished by the long, non-glandular hairs on the stem. Only one typical specimen has been collected outside of Guadeloupe, and strange enough, this comes from Mexico. A plant very closely related to it if not the same species is common in northern South America, but in this the inflorescence is more open and the sepals narrower. If not to be referred to *R. ferrugineus* it represents an undescribed species. The following specimens are referred to *R. ferrugineus*.

GUADELOUPE: 1893, *Père Duss 2215*.

MEXICO: near Tunbala, Chiapas, October 26, 1895, *E. W. Nelson 3305*.

ADENOTRICHI

Rubus adenotrichos is characterized by its long glandular hairs on the stem, its strongly armed petioles and petiolules, glabrous drupelets and rather broad leaflets, densely tomentose beneath. In the Torrey herbarium there is a duplicate of the type. In the herbarium of the New York Botanical Garden there is one of Liebmann's specimens with still broader leaflets, and shorter glandular hairs, approaching *R. costaricanus*, with which species this has been confused. Otto Kuntze referred his specimens to that species, but collected, also, specimens of the true *R. costaricanus*. The following specimens belong here:

VERA CRUZ: Jalapa, *Schiede* (type); Orizaba, 1853, *Fred Mueller 3001;* near Jalapa, 1900, *Pringle 8346* (erroneously named *R. coriifolius*); Mirador, 1841–43, *Liebmann 1675*.

OAXACA: Sierra de San Felipe, 1894, *Pringle 4695*.

COSTA RICA: June, 1874, *O. Kuntze;* Cartago, August 24, 1874, *O. Kuntze 2207*.

Rubus costaricanus differs from *R. adenotrichos* in the broader leaflets, more than half as broad as long, the short glandular hairs, scarcely longer than the other pubescence, the dense inflorescence and the few large drupelets. The New York Botanical Garden has received from Copenhagen a duplicate from Professor Oersted's collection. This is duplicated by the specimens collected by Otto Kuntze.

COSTA RICA: Cartago, 1845–48, *Oersted 1689;* Costa Rica, June, 1874, *O. Kuntze;* Turrialva, June 21, *O. Kuntze 2235;* Vulcan Irazu and Cartago, June 1874, *O. Kuntze;* Hacienda Belmira, near Santa Maria de Dota, 1898, *Tonduz 11615, 1450;* Parrita Grande du Copey, 1898, *Tonduz 11726* in part.

Rubus Verae-Crucis Rydb., described in the North American Flora, is related to *R. adenotrichos*, but differs in the pubescence, the leaves being nearly glabrous beneath and the stem with short glandular hairs. The species is only known from the type locality. New shoots were also collected in 1899, *Rose & Hough 4295*. Besides these I have seen only the following specimen, *Pringle 8177*.

Rubus irasuensis Liebm. The New York Botanical Garden has received from Copenhagen a specimen from Professor Liebmann's type collection of this species. The species is more com-

mon than expected, having been confused with both *R. adenotrichos* and *R. poliophyllus*. It is related to the former, but the glandular hairs of the stem are much shorter, scarcely longer than the other pubescence and the drupelets are slightly hairy at the apex. The following specimens belong to it:

COSTA RICA: Mount Irazu, 1847, *Oersted 1699;* Parrita Grande du Copey, 1898, *Tonduz 11726* in part; San Francisco de Guadeloupe, February 1893, *Tonduz 7304*.

GUATEMALA: Mizco, Dept. Guatemala, February, 1892, *John Donnell Smith 2534* (labeled *Rubus adenotrichos* var. *floribus roseis*); Volcan de Fuego, Dept. Zacatepeques, March 1892, *2535* (this was determined as *R. poliophyllus*); Antigua, February 1908, *Kellerman 7455;* Volcan d'Agua, February 15, 1905, *Kellerman 4775;* Ravanal, August 15, 1860, *Sutton Hayes*.

Rubus miser Liebm. seems not to have been collected since Oersted's time in Costa Rica. The only specimen seen resembling it comes from Guatemala and in this many of the leaves are five-foliolate. The species differs from *R. adenotrichos* in the small racemose inflorescence and the short glandular hairs.

COSTA RICA: Cartago, 1845–48, *Oersted 1700*.

GUATEMALA: Sapote, Dept. Guatemala, March, 1890, *John Donnell Smith 1972*.

SCANDENTES

Rubus scandens Liebm. This species is well described by Liebmann, but for some reason it has seldom been correctly identified, perhaps on account of the description of the fruit. Liebmann describes this as being red, with few drupelets falling off separately. In Liebmann's specimens, of which one is in the herbarium of the New York Botanical Garden, the drupelets are a dozen or less mostly fallen off. Dr. Focke describes the fruit as being red or dark purple and composed of six to eight large drupelets. In Nelson's specimens the drupelets are up to twenty, but the plants are in other respects identical with Liebmann's specimens. The following specimens have been seen:

VERA CRUZ: Mirador, March, 1841, *Liebmann 1701;* same locality, February 1894, *E. W. Nelson 194;* Zacuapan, January 1905, *Purpus 2953;* Canton de Huatusco, December, 1898, *Conzatti*.

Rubus fagifolius Cham. & Schlecht. I have seen no specimens of this species, but both Schlechtendahl's and Liebmann's descriptions, as well as the illustration given by Focke, show clearly that it is closely related to, but perfectly distinct from, *R. scandens*.

FLORIBUNDI

Rubus philyrophyllus Rydb. This species was first described as *R. tiliaceus* by Liebmann, but afterwards the name was changed to *R. tiliaefolius* by Dr. Focke on account of the earlier *R. tiliaceus* Smith. When proposing the new name Dr. Focke knew that there was a *Rubus tiliaefolius* Weihe, but he claims that the latter is a synonym and hence the name is available. There is a difference of opinion concerning this fact, and some authors regard also *R. tiliaceus* Smith as a synonym, which would make *R. tiliaceus* Liebm. available. The use of homonyms will always cause confusions and an unstable nomenclature. The permitting of the use of homonyms is one of the few features which makes it impossible for me conscientiously to subscribe to the, in general, excellent Vienna Code. I have seen no specimens, only a photograph of Liebmann's type. The leaf-form is, however, very distinct. Only two species and these of the *R. sapidus* group have leaflets approaching those of this species in outline, but in both the fruit is glabrous.

Rubus Liebmannii Focke. The specimens collected at Cerro de Sempoaltepec, Oaxaca, were included in *R. tiliaceus* by Professor Liebmann. The leaves of these specimens are quite different from those of the type of *R. tiliaceus*. In the herbarium of the New York Botanical Garden there are two photographs, one from the specimen in Liebmann's herbarium with Dr. Focke's label on it, the other from the specimen in Dr. Focke's own herbarium. The following specimens, which agree with these photographs as well as with Focke's description, I refer to this species.

OAXACA: northwestern slope of Mt. Zempoaltepec, July 10, 1894, *E. W. Nelson 675*.

VERA CRUZ: Orizaba, 1853, *Fred Mueller 1341*.

Rubus coriifolius Liebm. was described by Liebmann as having few carpels and rose-colored petals. One of Liebmann's specimens in fruit is found in the herbarium of the New York Botanical

Garden, and in this the drupelets are eight to ten, but in Pringle's specimen from Orizaba, they are twelve to twenty. The petals are about as large as those of *R. Schiedeanus*. They were described as pink, but they are often pure white. The following specimens I refer to this species:

VERA CRUZ: Mirador, February, 1842, *Liebmann 1688;* hill near Orizaba, February 3, 1895, *Pringle 5925*.

OAXACA: Totontepec, July 15, 1894, *E. W. Nelson 773;* between Juquila and Nopala, March 4, 1895, *2424*.

Rubus Schiedeanus Steud. This differs from the preceding species mainly in the toothing of the leaflets. In this the teeth are very small, more distant or obsolete; in *R. coriifolius* they are irregular, large and sharp, lanceolate, close together and directed forward. I have seen only the following specimens:

VERA CRUZ: Mirador, February, 1842, *Liebmann 1705;* near Jalapa, April 2, 1899, *Pringle 8086*.

Rubus macrogongylus Focke. In the original description Dr. Focke does not cite any specimens. Some time ago I wrote him and he kindly sent me a photograph of the type and wrote a letter, from which I hereby give the following extract: "The best characteristic for *Rubus macrogongylus* is or seems to be the shape of the fruit, which is *elongated* and consists of about 100 or more perfect carpels. In the flowering branches most of the leaves are quinate. The sepals are loosely reflexed in flower, afterwards they embrace the base of the fruit. At first I saw such plants in Donnell Smith Guatem., 4472, but the materials were not sufficient for describing and naming them. I suggest that Donnell Smith Guatem. 4178 will prove to be a form of the same species. Some years ago I met with, in the Berlin Herbarium, several flowering or fruiting specimens from Mexico. The panicle in these plants was much more developed than in the Guatemala ones, but I cannot distinguish leaves, tomentum, serrature, flowers or fruits. I send a photo of a flowering branch from Mexico. I think that the Mexican specimens represent the true face of the species, and that those from Guatemala are somewhat scraggy forms."

The photograph was labeled "*Rubus macrogongylus* Focke, S. Mexico Ex hb. Berlin." There was no indication of the collector

or date. Besides the two numbers of Captain John Donnell Smith's collection, cited by Focke in his letter, I have seen only a fragment, which I refer doubtfully here.

GUATEMALA: 1906, *Kellerman 5217*. (This was determined as *Rubus guyanensis*, to which it evidently does not belong.)

Rubus Smithii Rydb. This was orignally described as *R. poliophyllus* by Focke, but there is an older *R. poliophyllus* O. Kuntze. As it was based on *R. coriifolius* Focke in Enumeratio Plantae Guatemalensis, which appeared without description, *John Donnell Smith 2141* must be regarded as the type. Focke also cites *Seler 879* from Atlamaltatle, Hidalgo, Mexico, and *Smith 2533* and *2535* from Guatemala. The last number, at least as represented in Captain Smith's herbarium, does not belong to the same species as the others, but to *R. irazuensis* Liebm. Also *Kellerman 4775*, from Guatemala, and *Tonduz 11726*, from Costa Rica, both named *R. poliophyllus* belong to *R. irasuensis*. *Pittier 2281* and *Tonduz 7837* both from Costa Rica and both named *R. poliophyllus* belong to *R. Pittieri*.

Rubus Uhdeanus Focke. In the herbarium of the New York Botanical Garden, there are two photographs of and scraps from the type collection of this species, kindly sent us from the Royal Botanic Garden at Berlin. Besides these I have seen no specimen that could be referred to this species except the following:

MEXICO: Sierra de Ajusco, *Pringle 8279*.

Rubus Pittieri Rydb. This is somewhat related to *R. Uhdeanus*, having the same pubescence and more or less glandular inflorescence, but the branches and petioles are densely villous and the inflorescence more distinctly prickly. The plant therefore approaches the *R. sapidus* group, if it should not be included in the same; the plant, however, judging from the specimen seen, does not climb over bushes and rocks but is an erect shrub. In some respects it resembles *R. coriifolius*, but the petals are much smaller, and the drupelets smaller and more numerous. Dr. Focke refers the type number of this species to *R. poliophyllus* Focke, i. e., *R. Smithii* Rydb., to which disposition I cannot agree. The following specimens belong here:

COSTA RICA: Paramos de l'Abejonal, May 4, 1890, *Pittier 2281;* same locality, April, 1893, *Tonduz 7837*.

Rubus abundus Rydb. This name was substituted for *R. floribundus* H.B.K., which is a homonym. This has been reported for Central America, but I have not seen any material from there; I have, however, seen several specimens from Venezuela and Colombia. Otto Kuntze collected the species near Caracas, but referred it to varieties of *R. jamaicensis*. The following varietal names appear on his labels: *floribundus*, *normalis*, and *nudicaulis*. Though related to *R. jamaicensis*, it is easily distinguished from the same by its densely villous-velutinous leaves, which are deeply cordate at the base and never white on the lower side, and by its dense inflorescence and ovate, instead of lanceolate, sepals. Dr. Focke described a subspecies *Selerianus* of this species from material collected in Mexico, *Seler 2096*, which I have not seen.

Rubus laxus Rydb. was described in the North American Flora. It was also described by Dr. Focke as *Rubus adenotrichos leptaleos*,* but is not related to *R. adenotrichos*. It is related to the preceding, but differs in the open inflorescence, divergent branches of the same, the smaller flowers, the narrower and less or not at all cordate leaflets and shorter and finer pubescence. Specimens seen are the following:

GUATEMALA: Zamorora, Dept. Santa Rosa, *Heyde & Lux 4474;* Volcan Jumaytepeque, Santa Rosa, *Heyde & Lux 4473*.

Rubus jamaicensis L. This seems to be confined to the island of Jamaica. Specimens so named from South America belong to *R. abundus*, *R. alpinus*, or other related species. Mr. John Hart, Superintendent of the Cinchona Plantation, has collected specimens with the terminal leaflet of the lower leaves very broadly cordate and the inflorescence more compact. These approach somewhat *R. abundus*.

Rubus alpinus Macf. Unfortunately, I have not seen the original description published by Macfadyen. The descriptions given by Grisebach and by Focke do not fully agree. The former describes the plant, as well as *R. jamaicensis*, as shrubby, trailing, and the drupelets as numerous; the latter describes the plant as climbing and the drupelets as twenty to thirty. The plant found in Jamaica and the only one which agrees in any way with the descriptions of *R. alpinus* is a plant closely

* Bib. Bot. **83**: 70. 1914.

related to *R. jamaicensis*, but without the white tomentum on the lower surface of the leaves and being in all respects less pubescent. This has the same habit as *R. jamaicensis*, being reclining over bushes. Grisebach compares it with *R. fagifolius*. This was probably the reason why Focke transferred it to his subgenus *Lampobatus* and associated it with *R. fagifolius* and *R. scandens*. For my part it seems as if the Jamaican plant was unknown to Dr. Focke. Under any circumstances, the plant which I take for *R. alpinus* is the same as *R. guyanensis* Focke. At least I have not been able to find any differences. A photograph and some fragments of the type of *R. guyanensis* were kindly sent me from the Botanical Garden at Berlin and these are exactly like Shreve's specimens of *R. alpinus* from Cinchona, Jamaica. Other specimens from Guiana are the same. Otto Kuntze's specimens from Venezuela are similar but more pubescent, at least on the veins of the under side of the leaves. Specimens collected near Cinchona, *Harris 9141*, have the leaves more pubescent beneath, and may be hybrids with *R. jamaicensis*.

Rubus vulcanicola (J. D. Smith) Rydb. is closely related to the preceding and mainly distinguished by the mostly five-foliolate and more shining leaves, and longer pink or rose petals. I have seen the following specimens:

COSTA RICA: Volcan Poas, March 1896, *John Donnell Smith 6495;* 1896, *Tonduz 10907;* Rancho del Achiote, Volcan Poas, 1889, *Pittier 806;* Volcan Barba, 1890, *Tonduz 2120.*

SAPIDI

Rubus Nelsonii Rydb. is probably related to *R. sapidus* but differs from that species as well as from its other relatives in the narrower, long-acuminate leaflets, and also in its terete stem. It is known only from the two sheets of the type collection.

Rubus amplior Rydb. is related to *R. sapidus*, but differs in the terete stem, the dark green and firm leaflets, these being less cordate, and having broader teeth. Known only from the type collection.

Rubus Palmeri Rydb. is closely related to *R. sapidus*, but the leaves are lighter green, the inflorescence somewhat glandular, as well as villous-tomentose and the teeth of the leaves are broader

and shorter, and less strongly directed forward. To this species belong:

DURANGO: San Ramón, 1906, *Palmer 78.*

JALISCO: mountains near Talpa, March 7, 1897, *E. W. Nelson 4019;* between Dolores and Santa Gertrudis, August 7, 1897, *Rose 2039.*

Rubus sapidus Schlecht. A duplicate of the type of this species is in the Torrey herbarium. Typical specimens have been collected near the type station (Jalapa), *Pringle 8071.* These were wrongly determined as *R. huministratus* Steud., which species belongs to another group of the genus. Dr. Focke has included *R. sapidus* in the *Suberecti*, in which section he also included our *Arguti. R. sapidus* has subcoriaceous leaves, as most Mexican species have, and is not an erect plant.

Rubus Tuerckheimii Rydb. This is evidently also related to *R. sapidus*, but differs from all the species of this group in the small petals. It is perhaps most closely related to *R. amplior*, but differs in the finer and more regular toothing of the leaflets, the more numerous flowers and the small petals. Known only from the type.

Rubus alnifolius Rydb. was referred to the *Sapidi*, but is not closely related to any of the species of the group. It is characterized by the racemose inflorescence and the coriaceous leaflets, obtuse or rounded at both ends. It is only known from the type collection.

DURI

Rubus durus Sauvalle. This is characterized by its narrow inflorescence, coriaceous, shining leaflets, which are mucronate-serrulate and glabrous on both sides or nearly so beneath. Focke describes a variety *Grisebachii* with the leaves ferrugineous-villous beneath. This is unknown to me. I have seen but the following specimen of the species:

CUBA: *Wright 2410.*

Rubus florulentus Focke. This differs from the preceding in the open corymbiform inflorescence and glabrous drupelets, and larger petals. To it belongs:

PORTO RICO: Adjuntas, 1885, *Sintenis 4100.*

Rubus Eggersii (Focke) Rydb. *R. florulentus Eggersii* Focke.

This I think distinct from *R. florulentus*. Its leaves are similar but not so shining, and they are densely ferrugineous-pubescent beneath.

SANTO DOMINGO: near Constanza, 1910, *Von Tuerckheim 2913*.

Rubus domingensis Focke. I have seen no typical material of this species, but the following was so named by Dr. Focke. It does not exactly agree with the description, but may be rightly determined. If so, *R. domingensis* has less coriaceous leaves than the rest of the group.

SANTO DOMINGO: near Constanzia, 1910, *Von Tuerckheim 3140*.

URSINI

Rubus ursinus Cham. & Schlecht. All the species of blackberries on the Pacific coast have usually been included in this species. If so, the species must be a very variable one. The plants of the Columbia valley have glabrous, subglobose fruit, thin only sparingly pubescent leaves, and the leaves of the young shoots are rarely unifoliolate. The common plant of southern California has pubescent elongate fruit, thick leaves, densely pubescent beneath, and those of the new shoots usually unifoliolate. These two forms represent respectively *R. macropetalus* Dougl. and *R. ursinus* Cham. & Schlecht. But all plants of southern and central California do not have thick leaves and occasionally plants are found that have glabrous fruit. These, however, do not have the habit and globose fruit of *R. macropetalus*. These variations have caused most botanists to regard all as forms of one species. I think that a better solution is to admit at least five species of this group on the Pacific coast. If so, what names are they to have?

The southern Californian plant mentioned above is *Rubus ursinus* Cham. & Schlecht. The type was from the vicinity of San Francisco, near the northern limit of the species. Dr. Focke has pointed out that *R. Menziesii* Hook. is the same and not the plant related to *R. spectabilis*, which Dr. Watson called *R. spectabilis Menziesii*. The confusion has probably been caused by the fact that Dr. Hooker suggested that the flowers were pink. The rest of the description, however, agrees better with *R. ursinus*. The type of *R. Menziesii* was also from San Francisco, where the other species grows. *R. ursinus* is the most common of the

species in the southern part of the Pacific slope. Dr. Focke in his final monograph in Bibliotheca Botanica calls it *R. ursinus Menziesii*, making *R. macropetalus* the typical *R. ursinus*.

Rubus vitifolius Cham. & Schlecht. was described from a branch bearing only unifoliolate leaves, but the description of their texture and pubescence does not agree with the common plant. As there is a thin-leaved and less pubescent plant with pubescent fruit growing in the region, and this agrees with the description of *R. vitifolius*, I adopted that name without hesitation. It is also without much doubt *R. ursinus glabratus* Presl. It is represented by the following specimens:

CALIFORNIA: San Francisquito Creek, Santa Clara County, 1902, *Abrams 2435;* Mt. Tamalpais, 1905, *Rydberg 6245;* Albion Ridge, Mendocino County, 1903, *McMurphy 275;* Crystal Spring Lake, 1903, *Elmer 4664;* Stanford University, 1902, *Baker 857;* without locality, *Kellogg & Harford 223;* San Bernardino, *Parish 292;* Mount Shasta, 1892, *Palmer 2570.*

Rubus Helleri Rydb. As stated before, the common plant of the Columbia region has glabrous fruit, but a few specimens collected in that region have finely pubescent fruit and these have the leaves much darker-green above and of a firmer texture. These specimens are all from stations west of the Cascades. I believe they represent a distinct species. As I found no available name for it, I dedicated it to Mr. Heller, who has collected the best specimens of the same.

WASHINGTON: Montesano, 1898, *Heller 3990.*

BRITISH COLUMBIA: Alberni, Vancouver Island, 1907, *Rosendahl 2041.*

Rubus Eastwoodianus Rydb. Not all the blackberries of California have pubescent fruit. The glabrous-fruited specimens do not belong, however, to *R. macropetalus*, for the fruit is very much elongate and the leaflets are of a different shape. I think they belong to a distinct species, which I had the pleasure to name after one of the most enthusiastic and indefatigable botanists of the western coast, who also acted as my guide on Mount Tamalpais, when the type was collected.

CALIFORNIA: Mount Tamalpais, 1905, *Rydberg 6238;* Pasadena, 1903, *George B. Grant 3670*, doubtfully referred here; so also Jomacha, San Diego County, *Chandler 5225* in small part only.

Rubus macropetalus Dougl. This was mainly described from the staminate plant, while *Rubus myriacanthus* Dougl., described at the same place, is characterized from a more than usually prickly pistillate individual.

LACINIATI

Rubus laciniatus Willd. The origin of this species seems to be unknown. It has been cultivated more than a century at least, is not unknown in gardens, and has become naturalized at many places. The following specimens may be recorded:

WASHINGTON: Chehalis River, 1897, *Lamb 1244;* Quiniault Valley, 1902, *Conard 216;* Montesano, 1898, *Heller 4001*.

OREGON: Forest Grove, 1894, *Lloyd;* Oregon, 1903, *Lunell*.

BRITISH COLUMBIA: vicinity of Nanaimo, Vancouver Island, 1908, *John Macoun 19659;* Victoria, *John Macoun 19658*.

PENNSYLVANIA: Point Pleasant, 1898, *Fretz;* Bethlehem, 1905, *Rau*.

DISCOLORES

Rubus Linkianus Ser. This is usually known as *Rubus fruticosus* among gardeners but has little to do with the original *R. fruticosus* L., which belongs to another group of blackberries. *R. Linkianus* has usually double flowers in cultivation and most escaped plants also bear such; the simple-flowered state is found in the United States only as a ballast plant.

NEW JERSEY: Camden, 1897, *Pollard* (ballast).

MARYLAND: Frederickstown, 1816, *Commons*.

Rubus cuneifolius Pursh has an extensive distribution from Connecticut to Florida but is practically confined to the coastal plains.

ARGUTI

Rubus sativus (Bailey) Brainerd. This was originally described as *R. nigrobaccus sativus*. President Brainerd raised it to specific rank, although the plant he really had in mind was not this but another species which I have named *R. Brainerdi* after him. Mr. Blanchard regards it as a cultivated form of *R. nigrobaccus*, but the plant is found in the wild state, although not very common. It may have arisen through the crossing between *R. nigrobaccus* with *R. frondosus* or *R. Baileyanus*, but it is now found further

north than either of these two species. It resembles much *R. Baileyanus* × *nigrobaccus* in the leaf-form, but has more coarsely toothed leaflets and an erect stem. The following specimens belong here:

PRINCE EDWARD ISLAND: between Summerside and Miscouche, 1909, *Blanchard 801* (sheet 2).

QUEBEC: Kingsmere Lake, 1906, *Rydberg 7944*.

ONTARIO: Ottawa, 1906, *Rydberg 7926*.

MAINE: Calais, 1909, *Blanchard 502;* Brownsville, *Blanchard 503*.

NOVA SCOTIA: Granville, 1909, *Blanchard 706;* Kentville, *Blanchard 707*.

NEW BRUNSWICK: Marysville, 1909, *Blanchard 601*.

CONNECTICUT: Southington, 1906, *Blanchard 97* (set 4); Portland, *Blanchard 97* (set 5); Meriden, 1904, *Andrews 18;* Southington, *Andrews 4*.

VERMONT: cultivated, *Blanchard 212;* Mendon, 1899, *Eggleston 1220*.

NEW JERSEY: Newfoundland, 1908, *Mackenzie 3126;* Lucceasunna, 1909, *Mackenzie 4149;* Mt. Arlington, *Mackenzie 1393;* Budd's Lake, *Mackenzie 1517, 1519*.

In some cases specimens are found intermediate between this and *R. nigrobaccus*. They may be hybrids, but as I have not studied these specimens in the field, no attempt has been made to segregate the hybrids.

Rubus nigrobaccus Bailey. This has been known since about a hundred years ago as *R. villosus*, having been mistaken for *R. villosus* Ait., which, however, is antedated by *R. villosus* Thunb. Who was first responsible for the error is hard to tell. Both Michaux and Pursh might have had this plant in mind, but both practically copied Aiton's description. Pursh, however, makes the following remarks: "Known by the name Black-berries," which would suggest this or *R. argutus* rather than *R. procumbens* or *R. plicatifolius*. The same year that Pursh published his Flora, although a little later, Bigelow's Florula Bostoniensis appeared, and here there is no doubt about what plant the author had in mind. Since that time the plant was known as *R. villosus* until Professor Bailey saw the type of Aiton's *R. villosus* and proposed

the new name for this. There may be another older name that some people would regard as available. Babington in Gardener's Chronicle,* objects to the fact that gardeners have distributed a "well-known" plant under a new name, *R. americanus*. He claimed: "It is singular that nurserymen will so often issue plants with new names when old and authentic ones exist, and may be discovered without much difficulty. The Blackberry issued under the name of *R. americanus* is the *R. villosus* of Aiton (Hort. Kew., ed. 1, vol. ii., p. 210), and well known under that name to American botanists, as I learn from Dr. Asa Gray. Why give a new name when one already exists? Why give us all the trouble which we have had to find out its real name? But there is a curious point connected with this issue under the name of *R. americanus*. In most cases *R. laciniatus* came with it, and is, as far as I have seen, the prolific fruiting plant. So we have two quite distinct plants issued together under one, and that a new name. Can nothing be done to put an end to these things? They can hardly be of any benefit to the tradesmen, even if that were any excuse."

The plant regarded as *R. villosus* by Gray and other American authors was not the same as *R. villosus* Ait. The plant, therefore, that Babington had in mind was our *R. nigrobaccus*. As a synonym is given under *R. americanus*, it is published according to the American Code, but which plant does it belong to, *R. villosus* Aiton or *R. villosus* of Bigelow and of Gray? This *R. americanus* is older than *R. americanus* Britton and therefore available. If regarded as the same as *R. villosus* Ait., which is cited as a synonym, it should take its place as that is antedated by *R. villosus* Thunb. It should then replace the later *R. plicatifolius* Blanchard, which is the same. If regarded as the same as *R. villosus*, as understood by Bigelow and Gray, it would replace *R. nigrobaccus* Bailey. But whom should we cite as the author of *R. americanus*? We could not very well cite Babington, who strenuously objected to the name. The best to do is therefore to regard *R. americanus* Hort. as "merely incidentally mentioned."

Blanchard, followed by Fernald, Britton, Bicknell, and Brainerd, has adopted *R. allegheniensis* Porter for this species. *R. allegheniensis* was based on *R. villosus montanus* Porter. When

* III. 2: 99. 1887.

Dr. Porter described this variety and compared it with *R. villosus* he did not mean by the latter *R. Andrewsianus* or *R. argutus*, for the glandular plant was well known to him. Even Professor Bailey held *R. allegheniensis* distinct. When Dr. Porter pointed out as the only differences the narrow dry fruit with its peculiar aroma and did not mention the presence of glands, it is evident enough that both were glandular, for Dr. Porter was too acute an observer not to notice the difference in pubescence between *R. nigrobaccus* and *R. argutus*. I am inclined rather to follow Porter's and Bailey's view and regard *R. allegheniensis* as a distinct species. Furthermore, Mr. Mackenzie, who is well acquainted with *R. nigrobaccus*, has collected *R. allegheniensis* in New Jersey and distributed it under a manuscript name, regarding it as distinct. The latter differs in the slender terete stem, the narrower leaflets on the new shoots usually acute instead of rounded or subcordate at the base, the narrower and drier fruit and the conspicuous yellow glands and smaller flowers. It is a rare plant, suggesting somewhat *R. canadensis* or *R. Randii*. Dr. Britton, noticing that the figures of *R. allegheniensis* in the first edition of the Illustrated Flora, poorly represented the common, glandular high blackberry had a new illustration made, evidently overlooking the fact that the original illustration was made from the type of *R. allegheniensis* Porter. As it is, *Fig. 1899* in the first edition illustrates the original *R. allegheniensis*, while *Fig. 2300* in the second edition is a good illustration of *R. nigrobaccus*.

Sometimes, especially in the north, *R. nigrobaccus* has a leafy-bracted inflorescence and then receives a very different aspect. Such specimens in flower may be taken for a distinct species, but there is no difference in the pubescence or in the leaf forms. It might be mistaken for a hybrid with *R. frondosus*, but that species is unknown in the region where these forms are most common. Such specimens are:

QUEBEC: island in Gatineau River, near Chelsea, 1906, *Rydberg 7933*.

ONTARIO: Ottawa, 1903, *Macoun 59967*.

NOVA SCOTIA: Yarmouth, 1901, *Howe & Lang 89, 107*; Halifax Harbor, *Howe & Lang 1594*.

Rubus allegheniensis Porter. See discussion under *R. nigro-*

baccus. It is a less robust plant than that species and suggests somewhat a slender depauperate woodland form of *R. nigrobaccus*, but the stem is perfectly terete, the sepals narrowly lanceolate and the fruit is elongate, tapering above, and of many small, rather dry drupelets. The plant also suggests a hybrid between *R. nigrobaccus* and *R. Randii*, but the latter species is not found in the region of *R. allegheniensis*. It is not at all the same plant as the hybrid collected by me in the Adirondacks.

Rubus argutus Link. The most distinct of the species of *Rubus* described by Blanchard is *R. Andrewsianus*. It is one of the most common and most widely distributed of our blackberries. It was not a "new" species, however, and was called *R. fruticosus* by Marshall. The trouble has been that it has been confused with *R. villosus* of American authors, that is with *R. nigrobaccus*. Blanchard has done us the great service of pointing out the distinctiveness of the two. His name is, however, not the oldest available name, for it is the same as *R. argutus* Link. Link's description is incomplete, for he evidently did not describe the new shoots in his diagnosis. Mr. Blanchard is not willing to admit that *R. Andrewsianus* is the same as *R. argutus* and claims that at best the latter is an abnormal form of the former. Professor Bailey has kindly sent me a photograph, taken from the type at Berlin. This photograph shows plainly the strongly angled, almost grooved stem and stout prickles, characteristic of *R. Andrewsianus*, and to my mind there is no doubt concerning the identity of the two. Even if *R. argutus* should not be the same, *R. Andrewsianus* is not the oldest available name, for *R. floricomus*, described by Blanchard himself a year earlier, cannot be distinguished from *R. Andrewsianus*.

Rubus floridus Tratt. is closely related to *R. argutus* and represents it in the south. Mr. Blanchard does not distinguish the two. *R. floridus* as a rule, however, is rather distinct, has thinner leaflets with finer pubescence, those of the new shoots usually narrower and more finely toothed; the prickles are also more curved and more flattened and the branches terete. The species may hybridize, which may explain the intermediate form from regions where their ranges overlap.

Rubus betulifolius Small is closely related to *R. floridus*, but

the leaves are still thinner and glabrous or nearly so. Slender forms, in which the branches are arching, resemble also somewhat *R. lucidus*, but the leaves are not persistent, not so shining and much thinner. The following specimens belong here.

ALABAMA: Auburn, 1898, *Baker 1590;* Spring Hill, 1909, *Mackenzie 4018;* Mobile, 1899, *Earle 2014.*

NORTH CAROLINA: Lake Catherine, *House 4517.*

ILLINOIS: National Stock Yard (opposite St. Louis), 1878, *Eggert.*

Rubus frondosus Bigelow has been misunderstood and not well known, probably because there were so few specimens in the herbaria. Mr. Blanchard had done a good deal in clearing up the confusion. *R. frondosus* is not so rare, however, as supposed, and has a rather wide range, extending as far west as Kansas and Iowa. The range north and south, however, is not so wide, only from Massachusetts to Virginia. It is evidently confined to the hardwood belt. *R. philadelphicus* is but a small-leaved form of the same.

Rubus recurvans Blanch. I cannot distinguish *R. arundelanus* Blanch. and *R. Jeckylanus* from the same. *R. recurvans* itself is not a very strong species, being closely related to *R. frondosus*. Mr. Bicknell does not regard it as distinct. *R. recurvans* has a more northern distribution, but the two come together in southern New England and New York.

Rubus Brainerdi Rydb. This plant Professor Brainerd had in mind when he raised *R. nigrobaccus sativus* Bailey to specific rank. It has nothing to do with *R. nigrobaccus sativus*, however. Its relationship is with *R. frondosus* on one hand and *R. Baileyanus* on the other. It cannot very well be a hybrid of the two, for the type station is practically outside the range of both species. Professor Brainerd regards it as a form of *R. recurvans*. The following specimens have been collected.

VERMONT: Otter Creek, Wrybridge, 1899, *Brainerd;* Twin Mountain, West Rutland, 1900, *Eggleston 2005;* 1899, *Eggleston 1209, 2661;* Weybridge, 1902, *Eggleston 2893.*

Rubus pergratus Blanch. This seemed to me for a long time as the hybrid of *R. canadensis* and *R. nigrobaccus* and it resembles in many points that hybrid, but both Mr. Blanchard and Professor

Brainerd, who have studied the plant in the field, claim that it is perfectly distinct, rather common and well-fruiting, and the latter stated to me that it did not act as a hybrid. Furthermore, it is found higher up in the mountains than *R. nigrobaccus*. It differs from *R. canadensis* × *nigrobaccus* in being almost glandless. If glands are present, they are sessile or subsessile. It may have originated as a hybrid, but evidently now is an established species. *R. orarius* Blanch., I think, should be referred here. The only difference is the somewhat broader leaflets.

Rubus amicalis Blanch. This was first described as *R. amabilis*, which name, however, was preoccupied and *R. amicalis* was substituted. It is closely related to *R. canadensis*, but is best kept distinct, although the characters are not very strong. It has a very limited distribution in the north. The following specimens belong to it.

NOVA SCOTIA: Digby 1909, *Blanchard 714;* road from Brazil Lake to Ohio, *Blanchard 713;* Kentville, *Blanchard 716;* Bridgetown, *Blanchard 715;* Pictou, *Blanchard 717;* between Antigonish and Lochaber, 1906, *C. B. Robinson 468;* Maybou, *C. B. Robinson 232.*

NEW BRUNSWICK: St. Stephens, 1909, *Blanchard 607;* Painsic Junction, *Blanchard 602;* Grand Bay, *Blanchard 609.*

MAINE: Kennebunk, 1905, *Blanchard 75;* Isle au Haut, 1909, *Arthur 50, 58.*

To this species I also refer some odd forms from Newfoundland with nearly unarmed stems 1–1.5 cm. in diameter, coarser toothed leaves and leafy inflorescence. Such are:

NEWFOUNDLAND: Topsail, 1901, *Howe & Lang, 1232, 1330.*

Rubus canadensis L. The history of this species has been given by Bailey and Blanchard, so nothing more needs to be said. *R. Millspaughi* Britton was based on southern specimens. These cannot be separated from the northern plant, not even as a variety.

Rubus elegantulus Blanch. This might be of a hybrid origin, the parents being *R. canadensis* and *R. nigricans* or *R. vermontanus*, but it is now a well established species and differs in many respects from the hybrids of those species. The stem is armed with weak prickles rather than bristles, and these are confined to the angles of the stem. It resembles *R. canadensis* × *nigricans* most, but the inflorescence does not have the gland-bearing bristles of the inflorescence of nearly all of the *R. nigricans* hybrids.

VERMONT: Londonderry, *Blanchard 248, 249;* Westminster, *Blanchard 185;* South Windham, *Blanchard 215, 216;* Strattom, *Blanchard 217;* Townsend, *Blanchard 214.*

NEW HAMPSHIRE: Alstead and Windham, *Blanchard 60, 220, 218.*

MAINE: Isle au Haut, 1909, *Arthur 51.*

MASSACHUSETTS: Southwick, *Blanchard 253.*

Rubus Randii (Bailey) Rydb. This may be a form or variety of *R. canadensis*, but to me it seems unlikely. The slender subherbaceous habit and light-green leaves and usually light-colored stem suggest distinctiveness enough, especially as I have seen them both growing in the same localities in the Little Moose Lake region of the Adirondacks.

NOVA SCOTIA: Halifax Harbor, 1901, *Howe & Lang 1578.*

MAINE: Mount Desert Island, *Rand & Redfield.*

VERMONT: Middlebury, 1899, *Brainerd;* Putney, 1902, *Blanchard 188;* Abby Pond, Ripton, 1898, *Brainerd;* Rutland 1900, *Eggleston 1994.*

MASSACHUSETTS: Dalton, 1903, *Blanchard 238.*

NEW YORK: Tannersville, 1906, *Rydberg 8018;* East Lake, Little Moose Lake region, *Rydberg 7866;* Lime Kiln Falls, *Rydberg 7894.*

PROCUMBENTES

Rubus cymosus Rydb. Until lately there was in southern Mexico only one species of *Rubus* of the northern dewberry type with thin deciduous few-nerved leaves, viz., *R. humistratus*. *R. cymosus*, however, cannot be confused with *R. humistratus*, for in the former the prickles are stout, flat, and strongly curved, but in the latter, straight and slender; in the former the flowers are several and cymose, in the latter usually solitary. *R. cymosus* is known only from the type collection.

Rubus oligospermus Thornber. This has been known for half a century, but has been confused with *R. trivialis* and *R. humifusus*. It does not have the solitary flowers of these two species, however, nor the evergreen leaves of *R. trivialis*, nor the slender habit and the weak straight prickles of *R. humifusus*. It was first collected by Thurber on the Mexican Boundary Survey. The following specimens belong to it.

DURANGO: City of Durango and vicinity, 1896, *Palmer 10.*

ARIZONA: Santa Rita Mountains, 1881, *Pringle;* Santa Catalina Mountains, 1881, *Pringle;* 1908, *Livingston & Thornber;* Huachuca Mountains, 1909, *Goodding 439.*

SAN LUIS POTOSI: *Schaffner 105, 474;* 1878, *Parry & Palmer 224.*

SONORA: Nogales, 1893, *Mearns 2640.*

Rubus rhodophyllus Rydb. This is a rare species and might have been taken for a prostrate form or a hybrid of *R. argutus*, but that species is not found in Mississippi. As it was for years known from only one collection, it might have been considered a freak, if it had not also been collected in Florida.

MISSISSIPPI: Point St. Martin, 1898, *Tracy 4107.*

FLORIDA: Duval County, 1894, *Fredholm, 458.*

Rubus invisus Bailey is a rather local and variable species and acts in certain ways as a hybrid. One of the parents might be *R. procumbens* or *R. Baileyanus*, but I know of no species that could be suggested as the other parent, as the coarse rather regular toothing of the leaves is unique. The following specimens belong here:

ONTARIO: Niagara Falls, 1901, *Macoun 34777.*

MASSACHUSETTS: Northampton, 1904, *Andrews 40.*

VIRGINIA: near Luray, 1901, *Steele 194.*

NORTH CAROLINA: Biltmore, 1896, *Biltmore herbarium 7994[e].* (This was originally labeled *R. Baileyanus* Britt. Later somebody has written in lead pencil, *R. Boyntoni* Ashe.)

Rubus Baileyanus Britton is not a very uncommon species, although its range north and south is rather narrow. It resembles in that respect *R. frondosus*, which represents it among the erect blackberries. The broad cordate or subcordate terminal leaflets of the new shoots, the thin pubescent leaves, the large unifoliolate leaves of the inflorescence and the more or less glandular pedicels distinguish this from all the dewberries, except *R. invisus*, from which it differs in the toothing of the leaves.

Rubus arenicola Blanch. This is a rather local species and may be of hybrid origin, but I do not know what parents to suggest. It is related to *R. Baileyanus* and *R. procumbens*. The former is not found in the region where *R. arenicola* grows. It

could be a hybrid between *R. procumbens* and *R. hispidus*, if the leaves were not rather densely hairy. It is, therefore, best to regard it as a distinct species.

NOVA SCOTIA: Granville, *Blanchard 731*.

ONTARIO: Humber River, *J. White 73076*.

MAINE: York Beach Summit, 1909, *Blanchard 515;* Kennebunk, 1905, *Blanchard 63*.

Rubus plicatifolius Blanch. This was first described by Aiton as *R. villosus*, but there is an older *R. villosus* of Thunberg, and the name is therefore not available. In this country the name *R. villosus* Ait. has usually been applied to *R. nigrobaccus*, sometimes to *R. argutus*. Professor Bailey discovered that the original *R. villosus* Ait. was not a blackberry but a dewberry. Aiton's plant has decidedly pubescent leaves, but Professor Bailey did not think this character was very important and therefore regarded it as a form of *R. procumbens* to which he applied the name *R. villosus*. *R. plicatifolius* is a northern plant, in the southern part of the range, limited to the mountain regions.

QUEBEC: island in Gatineau River, near Chelsea, 1906, *Rydberg 7941, 7932;* Kingsmere Lake, *Rydberg 7942*.

NOVA SCOTIA: Annapolis 1909, *Blanchard 732;* Dartmouth, *729*.

MAINE: Wells Beach, 1905, *Blanchard 64;* Bingham, *511;* Veazie, 1905, *Knight*.

NEW YORK: Tannersville, 1906 and 1908, *Rydberg 7959, 7980, 7963, 8018*.

NEW JERSEY: Budds Lake, 1905, *Mackenzie 1333*.

MINNESOTA: Centerville 1891, *Sandberg 697;* Basswood Lake, 1891, *F. E. Wood*.

Rubus aboriginum Rydb. resembles in many respects *R. Baileyanus*, especially in the texture and pubescence of the leaves, the foliaceous inflorescence, and the large flowers, but differs in the absence of glandular hairs, and in the ovate instead of broadly cordate terminal leaflet of the new shoots. The leaves of the inflorescence are not so broad.

OKLAHOMA: "Indian Territory," chiefly on the False Washita between Fort Cobb and Fort Arbuckle, 1868, *Palmer 68, 69*.

KANSAS: Riley County, 1895, *Norton 136;* Pottawatomie County, 1895, *Hitchcock 971*.

Rubus heterophyllus Willd. This is related to *R. procumbens*, but differs in the incised toothing of the leaves. It is not so common. *R. heterophyllus* was for a long time a so-called "lost" species. Nobody seemed to know what it was. Bailey thought that it must have been a hybrid of *R. procumbens*. For some time, I held the opinion that it must be either *R. procumbens* or else *R. villosus michiganensis* Card. The latter was described independently by Blanchard as a species under the name *R. geophilus*, though the type of the latter has less harsh leaves than usual. A photograph of the type of *R. heterophyllus* was kindly sent me from the Botanical Garden at Berlin, and this shows, without doubt, that it is the same as *R. villosus michiganensis* and *R. geophilus*.

Rubus flagellaris Willd. This species has also been lost for about one hundred years. Professor Bailey thought that it was not American, at least no specimens had he seen in any of the herbaria, and I have not seen any but those collected by Mr. Bicknell, who rediscovered it on Long Island and Nantucket Island. Some of his specimens match closely the illustration prepared by Professor Bailey from the type. It also agrees with Willdenow's description.

Rubus procumbens Muhl. This name appears first in Muhlenberg's catalogue of 1813, without a description. It was given as a synonym under *R. trivialis* in Bigelow's Florula Bostoniensis in 1914, Bigelow mistaking this species for *R. trivialis* Michx. The first description under the name *R. procumbens* appeared in Barton's Flora of Philadelphia. Torrey and Gray mistook it for *Rubus canadensis*. This mistake was pointed out by Professor Bailey, who adopted the name *R. villosus* Ait., not believing that the more pubescent plant, *R. plicatifolius*, was distinct. *R. villosus*, however, is not available, as there was an older *R. villosus* Thunb. I myself thought that *R. procumbens* Muhl. was the pubescent plant, wherefore I redescribed the present species under the name *R. subuniflorus*. It is evident, however, that Barton described the glabrate plant. *R. procumbens* is the most widely distributed of our dewberries.

Rubus Enslenii Tratt. This is mainly a southern species extending along the coast as far up as to Nantucket Island.

Bailey regarded this and *R. Baileyanus* identical, and Mr. Blanchard includes it in *R. procumbens*. Mr. Bicknell and myself think it distinct. It has the thin leaves of *R. Baileyanus*, but they are narrower and almost glabrous. The leaves of the new shoots are often but three-foliolate and the shoots themselves are often erect at first. The thin leaflets of a different shape distinguish them. In the southern states it is, next to *R. trivialis*, the most common dewberry. The following northern specimens belong to it.

MISSOURI: Forest Hill Cemetery, Jackson County, 1897, *Mackenzie;* Butler County, 1905, *Bush 2562 B;* St. Louis, 1878, *Eggert.*

NEW YORK: Bronx Park, 1906, *P. Wilson.*

MASSACHUSETTS: Pine Grove, Nantucket Island, 1908, *Bicknell 14;* below the cliff, Nantucket Island, *Bicknell 13.*

Rubus huministratus Steud. This species was first described under the name *R. humifusus*. As that name had already been used, Steudel substituted *R. humistratus*. It is easily distinguished from the other Mexican species by its slender habit, weak prickles and solitary flowers.

OAXACA: Puerto de Laskopa, 1842, *Liebman 1625.*

VERA CRUZ: Jalapa, 1899, *Rose & Hough 4364, 4935.*

HISPIDI

Rubus nigricans Rydb. This was first described as *R. hispidus erectus* by Professor Peck. Dr. Britton thought that it was identical with *R. setosus* Bigelow, but in separating the specimens in the Torrey herbarium, he placed some specimens collected by Bigelow with *R. hispidus*, not noticing that these were part of the type of *R. setosus*. Britton has been followed by Blanchard, Brainerd, and others. *R. setosus* is in reality closer to *R. hispidus* (except for the semi-persistent leaves of the latter) than to *R. nigricans*. Fernald, in the new Gray's Manual, has misunderstood *R. nigricans* and adopted the name for *R. vermontanus*. *R. Groutianus* I regard as a nearly glandless form of this species.

Rubus setosus was described in the second edition of Bigelow's Florula Bostoniensis. Dr. Britton for some time regarded this as the same as *R. nigricans* but later adopted Bicknell's view that it was a hybrid between that and *R. hispidus*. Blanchard and

Brainerd still regard it as the same as *R. nigricans*. The two are species, however, not quite identical. *R. setosus*, of which there are two sheets from the original collection in the Torrey herbarium, is a more slender plant with racemose inflorescence and thinner leaves. The flowers themselves resemble more those of *R. hispidus*. I would have been inclined to regard *R. setosus* as a freak or local form, if I had not collected the same form myself and been unable to refer the specimens to either *R. hispidus* or *R. nigricans*. The following I take to belong here:

NEW YORK: Tom Peck's Pond, near Lake Placid, 1906, *Rydberg 7952;* Long Pond, *Rydberg 7949, 7948;* Lime Kiln Falls, vicinity of Little Moose Lake, *Rydberg 7895;* Twin Lakes, *Rydberg 7823*.

CONNECTICUT: Southington, 1904, *Andrews 25*.

Rubus vermontanus Blanch. As said before this was mistaken for *R. nigricans* by Fernald, but is evidently distinct. It is a species confined to the northern woods.

VERMONT: Ripton, 1897, *Brainerd 201;* South Wadsboro and Grafton, 1902, *Blanchard 176;* Lily Pond, Westminster, *Blanchard 2;* West Jamaica and Ripton, 1902, *Blanchard 176;* Londonderry, 1903, *Blanchard 245;* Brookline, 1902, *Blanchard 58* (set 1); Grafton and Rockingham *Blanchard 58;* Mendon and Wallingford, 1900, *Eggleston 2007, 2006, 2857, 2858*.

CANADA: *Macoun 5793, 6097, 19072*.

Rubus hispidus L. This species is very well known and nothing further needs to be said.

TRIVIALES

Rubus lucidus Rydb. This is the same as *R. trivialis* β. of Hooker's Compendium and *R. persistens*, partly, of Small's Flora. The latter was based on this and some hybrid forms. Unfortunately, one of the latter was assigned as the type, and hence this species needed another name. It has also been confused with *R. trivialis*, but never bears any bristles, and the flowers are seldom solitary as in that species. The following specimens belong here:

FLORIDA: Dunedin, 1900, *Tracy 6855;* Tampa, 1903, *Britton, Britton & Shafer 19*.

ALABAMA: Auburn, 1897, *Earle & Baker* (mixed with *R. trivialis*).

MISSISSIPPI: Biloxi, 1898, *Tracy 4106.*

SOUTH CAROLINA: Hilton Head, 1864, *Eaton.*

Rubus trivialis Michx. is well known, although *R. lucidus* and *R. carpinifolius* have been mistaken for it. It is very variable as to the width of the leaflets. A peculiar form with narrowly lanceolate leaflets has been collected in Louisiana and Mississippi. It may represent a distinct species, but the material is too meager. The specimens of this form are the following:

LOUISIANA: Cat Island, Mississippi Delta, 1900, *Lloyd & Tracy 263.*

MISSISSIPPI: Biloxi, 1898, *Tracy 4114.*

Rubus carpinifolius Rydb. This is closely related to *R. lucidus*, but differs in the double-toothed leaflets of the new shoots. It is also sometimes as bristly as *R. trivialis*. The following specimens belong here:

TEXAS: New Brunnfels, 1850, *Lindheimer 791;* San Antonio, 1853, *Thurber;* Gillespie County, *Jermey* (named *R. occidentalis*); San Felipe, 1839, *Lindheimer.*

ARKANSAS: Fort Smith, 1853, *Bigelow* (Whipple Exp.).

MISSOURI: Eagle Rock, 1896, *Bush 18;* White River, 1896, *Mackenzie.*

LOUISIANA: Alexandria, 1899, *Ball 428.*

Rubus rubrisetus Rydb. is a very rare and local species. Only the following specimens have been seen:

MISSOURI: St. Louis, 1874, *O. Kuntze 2789; Bush 116.*

LOUISIANA: 1885, *Poggenburg; Biltmore herbarium 4488c.*

NEW YORK BOTANICAL GARDEN

INDEX TO AMERICAN BOTANICAL LITERATURE

1909–1915

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

This Index is reprinted monthly on cards, and furnished in this form to subscribers at the rate of one cent for each card. Selections of cards are not permitted; each subscriber must take all cards published during the term of his subscription. Correspondence relating to the card issue should be addressed to the Treasurer of the Torrey Botanical Club.

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A plant from Argentina.

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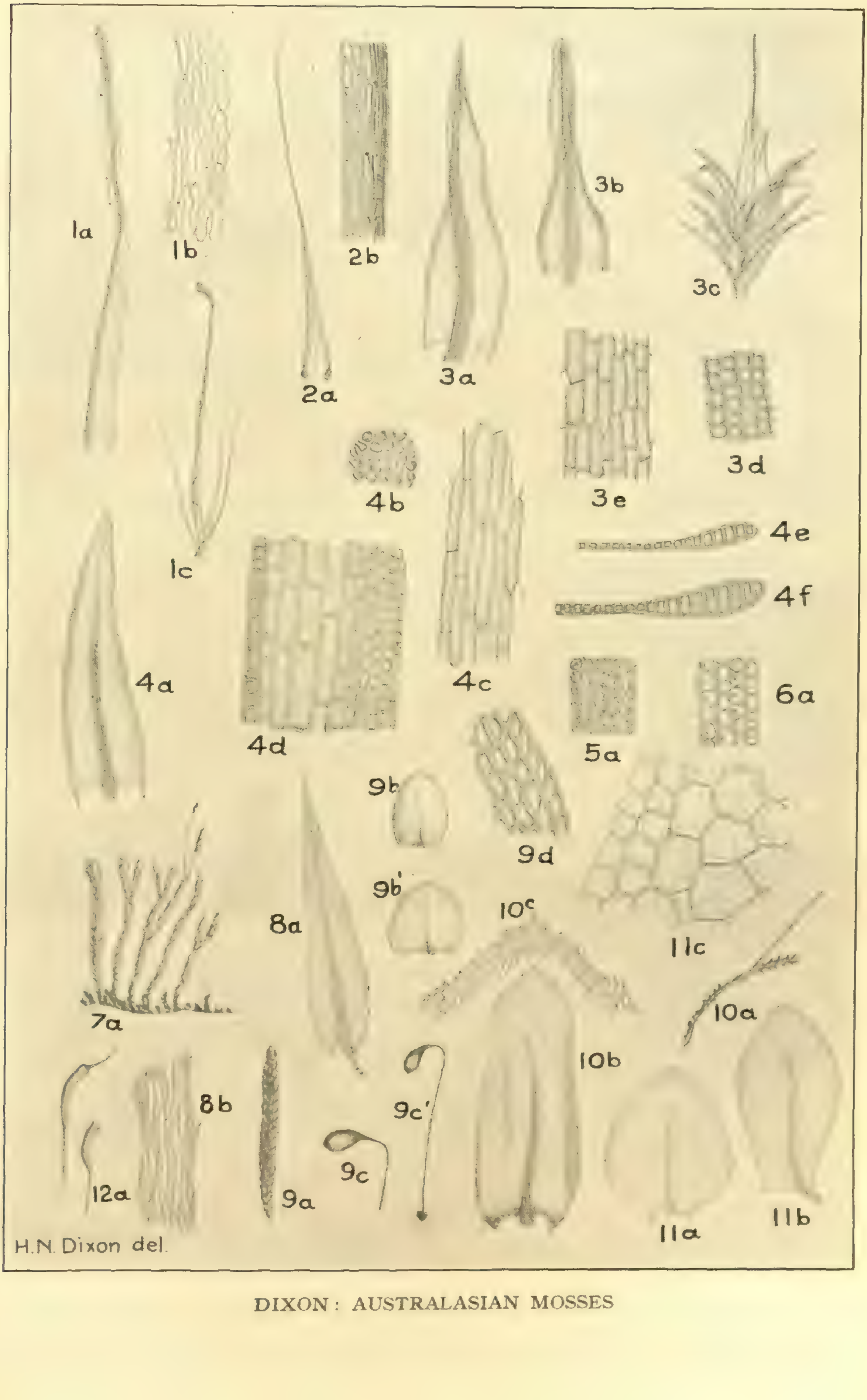

DIXON: AUSTRALASIAN MOSSES

Vol. 42 No. 4

BULLETIN

OF THE

TORREY BOTANICAL CLUB

APRIL, 1915

The vegetation of Connecticut
IV. Plant societies in lowlands*

GEORGE E. NICHOLS

(WITH FIFTEEN TEXT FIGURES)

The term LOWLAND, as used in the present paper, embraces primarily lakes, ponds, and swamps.† The word LAKE may be employed to designate any body of water surrounded by land, but more commonly this term is applied to relatively large bodies of water, smaller water bodies being referred to as PONDS. Throughout the present paper the two terms are used more or less indiscriminately. A SWAMP may be defined as any area where the ground is saturated with water throughout a good part of the year, but where, at least during most of the year, surface water does not accumulate. As will be seen presently, it is not always possible to differentiate absolutely between lakes and ponds on the one hand and swamps on the other. Thus, the transition from a lake to the swamp at its margin may be so gradual that one cannot say where the one leaves off and the other begins. Similarly, a swamp may merge by almost imperceptible gradations with the neighboring upland, so that it is likewise difficult to draw a sharp line of demarcation between lowlands and uplands.

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* Contribution from the Osborn Botanical Laboratory. The previous numbers of this series have appeared in Torreya **13**: 89–112; 199–215. 1913, and **14**: 167–194. 1914. In this paper, as in the others, the nomenclature followed is that of Gray's Manual, seventh edition.

† In earlier papers this term has also been used to designate one of the three geographic provinces into which the state is divided, *viz.*, Central Lowland, as contrasted with Eastern and Western Highlands.

[The BULLETIN for March (**42**: 93–168. *pl. 9*) was issued March 16, 1915.]

GEOLOGICAL RELATIONS OF LAKES AND SWAMPS

The Effect of Physiographic Factors on the Distribution of Lakes and Swamps.—In a general way it can be said that lakes and swamps belong to the same family, and differ only in age.* Lakes, however, "are temporary features of a landscape, and can only exist where the land has been recently raised above the sea or modified by some widely acting agent"† such as glaciers. Sooner or later they are destined either to be drained through the activity of streams cutting down their outlets, or else to be filled in through the washing in of inorganic sediment from without and the accumulation of vegetable debris from within.

Considered from the standpoint of their physiographic origin, Connecticut lakes may be grouped under three heads: GLACIAL, RIVER, and COASTAL. The term GLACIAL LAKE is here used in its broadest sense, to include lakes formed in any sort of a depression resulting from glacial activity. Glacial lakes may further be subdivided as follows: (1) MORAINAL LAKES—those associated with accumulated glacial debris of any description; and (2) SCOOP LAKES—those which occupy depressions scoured out of the underlying rock by the ice. Lake Saltonstall, near New Haven, affords a striking example of a scoop lake. This lake is about three miles long and has an extreme depth of 108 feet, more than eighty feet below sea level; yet notwithstanding that the tides rise and fall at its very edge, its water is fresh and constitutes part of the New Haven water supply.‡ On the whole, however, scoop lakes are far less abundant and of much less importance in Connecticut than morainal lakes, and of the 1,026 lakes indicated on the topographic map of the state§ the great majority belong to this latter class. Morainal lakes may originate under a variety of conditions. Thus, (*a*) they may occupy depressions in the ground moraine; (*b*) they may occur behind dams formed by the heaping up of glacial till; (*c*) they may occupy depressions in stratified drift; or (*d*) they may develop behind the ridges of stratified drift known as eskers. Morainal lakes of the first two types here mentioned

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* Possible exceptions to this statement are pointed out in later paragraphs.

† Rice, W. N., and Gregory, H. E. Manual of the geology of Connecticut, Geol. and Nat. Hist. Surv. Connecticut, Bull. 6: 248. 1906.

‡ See Rice and Gregory, *op. cit.*, p. 249.

§ See Rice and Gregory, *op. cit.*, p. 247.

are common throughout the state, but are especially characteristic of the higher, more rugged sections. Morainal lakes of the last two types are best developed in the lower, leveler, central portion of the state. Lakes occupying depressions in stratified drift are well exemplified by the "kettle-hole" ponds, so abundant in the sand-plains near New Haven; while Lake Compounce is a good illustration of a lake dammed in by an esker.

RIVER LAKES or PONDS for the most part are associated with old-age, meandering streams. In general, they are of two sorts: (1) OX-BOW and (2) MARGINAL. Ox-bow ponds, originating in flood time as a result of the abandonment of old water courses, are common along sluggish streams throughout the state (FIG. 1).

FIG. 1. Ox-bow swamp along Muddy River, North Haven. In the foreground are seen *Castalia odorata* (in the water), *Dulichium arundinaceum* (along the left bank), tufts of *Carex stricta* (on both banks). Elm, etc., in the background.

Marginal ponds are often caused by the deposition of sediment along the bank of a stream at high water, thereby gradually building up a sort of dike or ridge which cuts off the channel from

the remoter parts of its flood plain. When the stream overflows its banks these latter areas are flooded, and after the recession of the water there may be left behind more or less extensive shallow ponds. Such ponds may be seen along the Connecticut River and elsewhere, but usually they are of a very temporary nature. Far more common than marginal ponds are marginal swamps. These may originate in the manner just described, but more often seepage water is responsible in large measure for the maintenance of the swampy condition. Swamps due to seepage will be discussed presently.

COASTAL LAKES, PONDS, and SWAMPS are formed mainly behind barrier beaches, in sheltered bays and harbors, and along the lower courses of the larger rivers. The ecological relations of these will be considered in a later paper, in connection with plant societies along the coast.

The Effect of Topography and Ground Water Level on the Character of Lakes, Ponds, and Swamps.—It is evident that topography, as moulded by physiographic forces, is an all-important factor in governing the distribution of lakes and ponds. This is also true with respect to swamps, but it is further true, as will be pointed out presently, that swamps may be developed in areas where bodies of standing water could not exist. Yet while their development is dependent on suitable topographic conditions, the presence or absence of lakes, ponds, and swamps is further conditioned by the relation between the level of the land surface and the water table; and this in turn is influenced by the amount of precipitation and the character of the substratum. The surface of the ground water rises and falls with the land surface, but with smaller differences of elevation. Thus, while it reaches its highest elevation in the hills it stands farthest from the surface of the ground there. Similarly, in the depressions it stands lower, but is nearer the surface of the ground. Wherever it reaches the surface, lakes, ponds, streams, or swamps may be formed.* Owing to the variation in the amount of precipitation at different seasons of the year, the level of the water table is constantly

* For an extended discussion of the underground water resources of Connecticut, see Gregory, H. E., and Ellis, E. E., U. S. G. S. Water-Supply Paper 232, pp. 1–200, *pls. 1–5 + figs. 1–31.* 1909.

fluctuating. It is highest during winter and spring, the seasons of maximum precipitation; it is lowest in late summer, toward the end of the season of minimum precipitation. In the following paragraph, the writer has attempted to bring out, with the help of diagrams (FIG. 2), the important bearing which these various factors may have on the nature of lakes, ponds, and swamps.

With reference to their relation to topography and water table, four fairly distinct types of lowland may be recognized. (1) PERMANENT LAKES or PONDS.—Where the relationship between the controlling factors, i. e. topography and water table, is such that a tract of land is submerged to an appreciable depth by standing water throughout the year (FIG. 2, A), it is obvious that a permanent lake or pond will exist. It need hardly be remarked that such a water body can arise only within a completely enclosed basin. Lakes fed entirely by subterranean waters are not uncommon, but more frequently this source of supply is supplemented by surface streams. A permanent water body can exist in a closed basin only where the amount of water flowing in exceeds the amount lost through underground drainage plus the amount lost through evaporation. (2) INTERMITTENT LAKES or PONDS.—Very often the relationship between the various factors involved is such that a basin is filled with water in spring, but later in the season, as a result of the lowering of the water table plus increased evaporation, the surface water vanishes, leaving the bottom of the depression quite dry, or else merely swampy (FIG. 2, B). Shallow, intermittent ponds of this sort are of frequent occurrence, being especially well developed in parts of the sand plains north of New Haven. (3) PERMANENT SWAMPS.—It often happens that, in spite of an abundant supply of underground water, topographic relations are such as to prevent pond formation. Thus, seepage water may keep the ground on a side hill wet throughout the year, but as fast as the water reaches the surface it runs off to lower levels. Similarly there may be a series of perennial springs along the base of a hill, but in the absence of an enclosed basin of some sort to contain the water, pond formation manifestly cannot take place, and swampy conditions prevail. Ideal conditions for permanent swamps are presented by the flat floors of the old glacial drainage valleys, so common throughout central Connecticut. Lying well

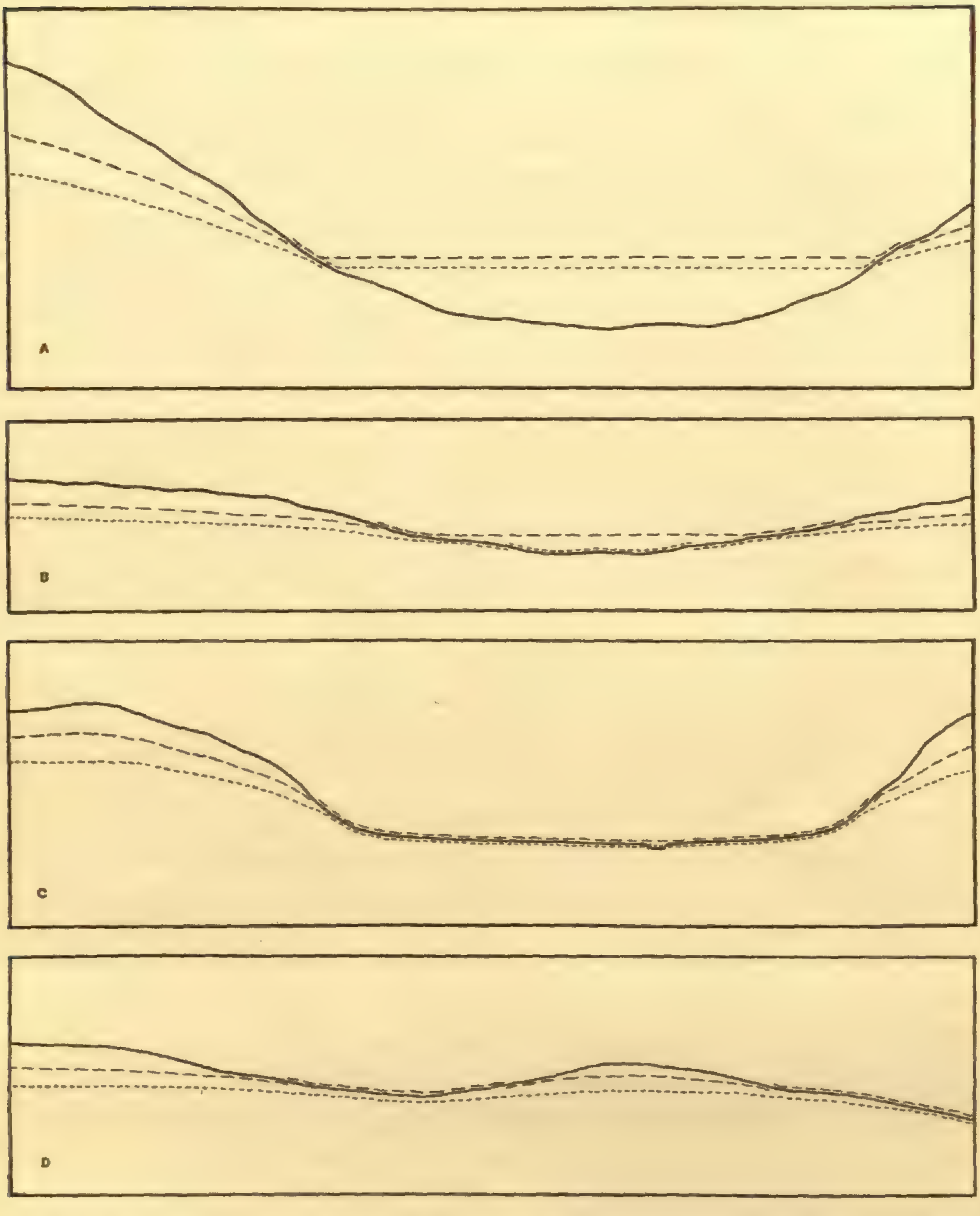

FIG. 2. Diagrammatic vertical sections to represent the relation of topography and level of ground water to character of lakes, ponds, and swamps. Surface of Ground represented by continuous line (———), Level of Ground Water in Spring by long dashes (– – – –), Level of Ground Water in Late Summer by short dashes (- - - - -). A. Permanent Lake or Pond. B. Intermittent Lake or Pond. C. Permanent Swamp; cross section of a glacial drainage valley. From this diagram the relations of topography and water table might at first thought appear identical with those represented by diagram A; but a longitudinal section would show this (C) depression to be in the nature of an open trough, rather than an enclosed basin (as in A). D. Periodic Swamp. For further discussion, see text.

below the general level of the water table at all seasons, as they usually do, the surface of the ground is kept constantly wet by springs and seepage water, but the surplus is continually being carried away by the small streams which drain these areas. A cross section of one of these glacial-drainage-valley swamps is shown by FIG. 2, C. (4) PERIODIC SWAMPS.—These bear much the same relationship to permanent swamps that intermittent ponds bear to permanent ponds. In other words, in an area where the relations between topography and ground water level are such as to preclude pond formation at any season of the year, but where the ground is saturated with water at certain seasons and dry at others, a periodic swamp may be said to exist. Swamps of this sort are common on every hand—in low grounds, in shallow depressions of any description (as in FIG. 2, D), and on side hills.

Between the four types of lake, pond, and swamp above described, all intergradations exist, so that it is not always easy to assign a given lowland area to a definite category. But while this classification is necessarily elastic, and while improvements can doubtless be suggested, the scheme here proposed, it is believed by the writer, will prove serviceable in the study of the vegetation of lowlands, not only in Connecticut but elsewhere as well.

THE RÔLE OF VEGETATION IN THE CONVERSION OF LAKES INTO SWAMPS

The important rôle commonly played by plants in the conversion of lakes into swamps has long been recognized, and the manner in which this transformation is brought about may appropriately be outlined at this point. When the plants in a lake die, their remains sink to the bottom where, because of insufficient oxidation, the vegetable debris is only partially decomposed. In this way there collects on the floor of the lake a layer of vegetable muck, or peat; and through the continued addition of fresh layers the deposit is gradually thickened and built upward. This constructive process may go on until ultimately the surface of the deposit reaches the level of the water, when the lake gives way to a swamp (see FIG. 3). But the rate at which the substratum is built up and the length of time which elapses before it reaches the water level varies greatly in different parts of a lake. As will

be shown presently, plants grow most luxuriantly in shallow water; they may be practically absent from the deeper areas. It follows, therefore, that the accumulation of muck or peat proceeds much more rapidly in shallow than in deep water—so much so, in fact, that the shoreward parts of a lake may have become completely filled in before any appreciable accumulation has taken place in the deeper areas. The filling in of deep lakes usually proceeds centripetally. This is due to the fact that the shoreward zones of vegetation, in consequence of their more vigorous growth, exhibit a tendency to push outward into deeper water. Where this tendency is pronounced, the shoal water zones may completely override the deeper water zones, at the same time causing the lakeward slope of the deposit to become much steeper.* The filling in of the deeper parts of a lake may also be effected to a varying degree by the accumulation of loose debris from the adjoining shallows or by the deposition of sediment in flood time, while various plankton forms may contribute in a small measure to the deposit. But as a rule, the encroachment of the shoal water vegetation is the most important agency in bringing about the filling in of the deeper parts of deep lakes. The most extreme development of this method of filling is seen in connection with floating mat formation (FIG. 10), the discussion of which is reserved for later paragraphs.

THE SUCCESSION OF PLANT SOCIETIES IN LAKES AND SWAMPS

Succession in Lakes.—Coincident with the upbuilding of the substratum through deposition of muck or peat, as outlined in the preceding paragraph, transformations occur in the character of the vegetation growing on the lake's bottom. For, as the depth of the water diminishes, it becomes possible for plants to develop which were unable to grow in the deeper water. And as these shallow water plants increase in number and abundance, they may crowd out and eventually replace the deeper water species. Thus there may follow one another a series of plant societies,†

* For a more detailed description of this process, see Davis, U. S. Dept. Interior, Bur. Mines, Bull. 16: 22, 23. 1911.

† The terms Plant Society and Plant Association, in the present series of papers, are used indiscriminately and in their broadest sense. Except in referring to the Climatic Formation, the use of the term Formation has been avoided.

each one of which, by helping to raise the bottom of the lake to a higher level, prepares the way for less hydrophytic societies, but at the same time, by so doing, brings about its own extermination.

It is a familiar fact that the plants which fringe the edges of so many lakes are commonly massed in more or less definite bands or zones that tend to be concentric with respect to the deeper parts of the lake. The floristic composition of these zones in any given lake is determined largely by the ecological requirements of the various species of plants which happen to be present, in relation to the depth and clearness of the water. In progressing from the deeper parts of a lake toward the shore (FIG. 3) the zones

FIG. 3. Diagrammatic vertical section through the marginal portion of a shallow lake which is being filled in through the accumulation of vegetable debris on the bottom, showing the succession of plant societies which may accompany the transformation of a lake into a swamp. Sequence of Zones (or Stages): (1) Pond-weed Zone; (2) Water-lily Zone; (3) Bulrush—Pickerel-weed—Cat-tail Zone; (4) Sedge Zone; (5) Shrub Zone; (6) Swamp Forest.

encountered, as characterized by the dominant plants, are usually: (1) the PONDWEED (*Potamogeton*) ZONE, (2) the WATER-LILY (*Castalia*, *Nymphaea*) ZONE, (3) the BULRUSH (*Scirpus*)—PICKEREL-WEED (*Pontederia*)—CAT-TAIL (*Typha*) ZONE (or ZONES), (4) the SEDGE (*Carex*, etc.) ZONE. Modifications of this arrangement are frequent, but in a general way the sequence is the same throughout the northern United States.

Reference has already been made to the succession of plant societies which accompanies the building up of the lake bottom. It has been found that this dynamic VERTICAL SUCCESSION corresponds closely with the apparently static HORIZONTAL ZONATION just outlined. Thus, in a hypothetical case, it may safely be assumed that the pondweeds now growing in a given locality are destined to be succeeded by water-lilies, the water-lilies by pickerel-weed, and these in turn by sedges. Conversely, sedges growing on a mucky shore have very likely been preceded by pickerel-weed, etc. This general coördination between the contemporaneous horizontal sequence of zones and the historical or vertical order of succession has been verified repeatedly by the stratification of plant remains observed in peat deposits, and is of great assistance in reconstructing the past or predicting the future course of events in any specific locality.

As has been pointed out by C. A. Davis in his comprehensive essays on the ecology of peat formation in Michigan,* there are relatively few of the highly organized vascular plants which can grow when entirely submerged in water. Thus, out of the more than 1,900 seed plants known to occur in Connecticut, scarcely ninety, or less than five per cent., have this ability. "Of these plants which will grow in water, only a few, mainly *Potamogetons* or pondweeds, can establish themselves at a depth greater than ten feet from the surface, while the majority of submerged plants grow in less than six feet of water, unless it is unusually clear."† The maximum depth at which seed plants can grow rarely exceeds fifteen to eighteen feet, so that the deeper parts of many lakes, owing to insufficient light, heat, and aeration, are practically destitute of vegetation. The first stage in the succession of plant associations which accompanies the filling in of a lake is the POND-WEED STAGE, characterized by the predominance of submersed aquatic plants, especially of species of *Potamogeton*. This genus is represented in Connecticut by no fewer than twenty-eight species, the commonest submersed forms of which are *P. Robbinsii*, *P. Richardsonii*, *P. pusillus*, *P. amplifolius*, and *P. heterophyllus*. The two species last named are capable of develop-

* Geol. Surv. Michigan 1906: 97–286. 1907.

† Davis, 1907, *loc. cit.*, p. 129.

ing two sorts of leaves, viz., submersed and floating; but the latter type is seldom formed on plants growing in water more than five feet deep. Flowers likewise are usually suppressed, except in shallow water, reproduction being accomplished solely by vegetative means. Other plants frequently present in considerable abundance in the pondweed association are *Najas flexilis*, *Vallisneria spiralis*, and *Elodea canadensis*. The lack of dependence of many of these water plants on the sexual methods of reproduction is well exemplified by the latter species. Introduced into Europe from America about 1836, this "Wasserpest" has become widely spread over that continent, notwithstanding that it has never been observed there in fruit. FIG. 4 shows a

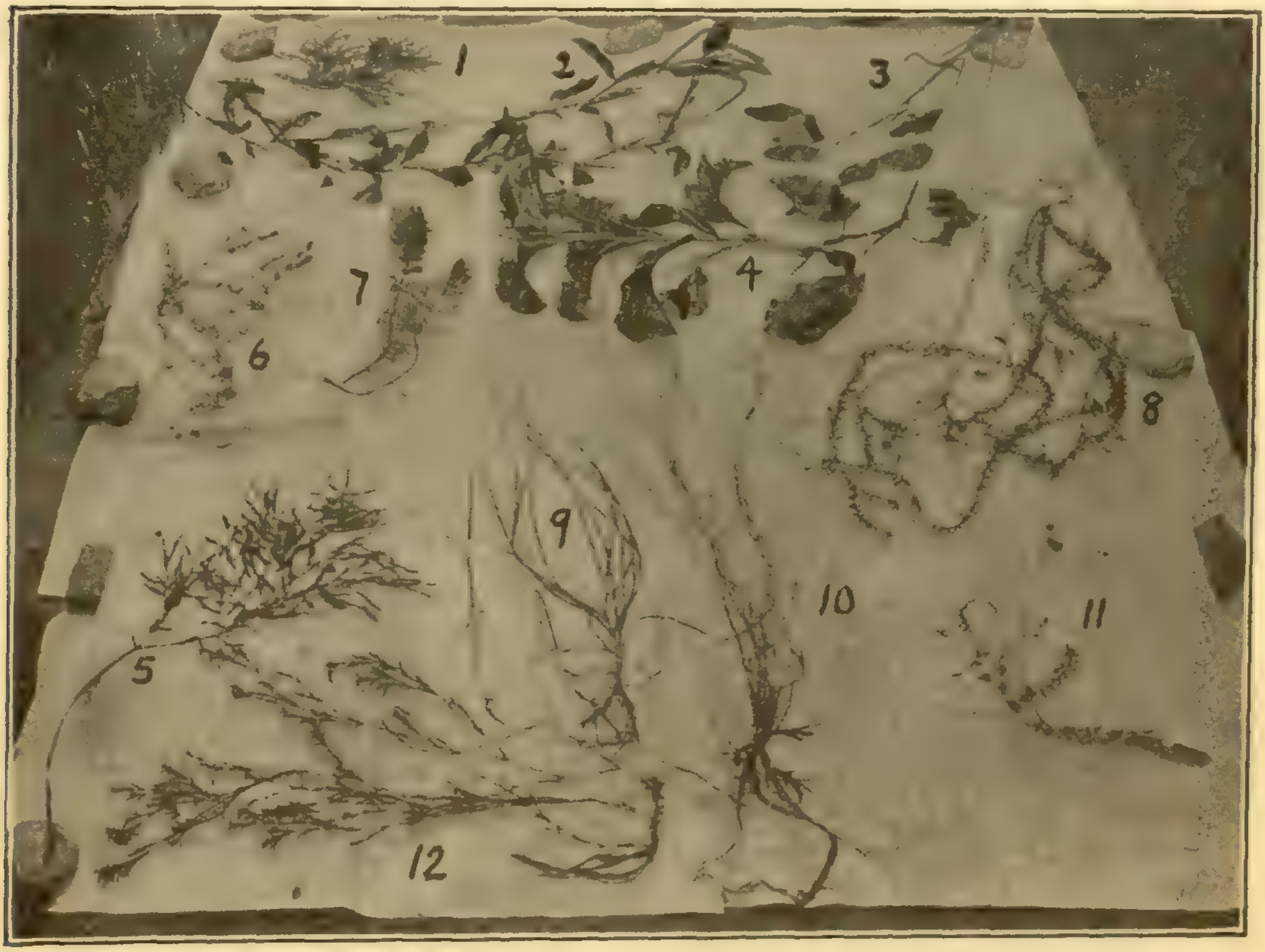

FIG. 4. Submersed aquatics from Twin Lakes, Salisbury. The plants were placed on papers in the bottom of a boat and photographed fresh. Species shown are as follows: 1. *Potamogeton pectinatus;* 2. *P. lucens;* 3. *P. natans;* 4. *P. amplifolius;* 5. *P. heterophyllus;* 6. *Chara* sp.; 7. *Ceratophyllum demersum;* 8. *Elodea canadensis;* 9. *Sparganium minimum;* 10. *Eleocharis Robbinsii;* 11. *Utricularia intermedia;* 12. *Najas flexilis.*

representative collection of aquatic plants from a lake in northern Connecticut. The majority of such plants have roots and grow attached to the bottom, but there are a number of forms, notably

the bladderworts (species of *Utricularia*), *Ceratophyllum demersum*, and sometimes *Ranunculus aquatilis*, which are free floating and entirely unattached to the substratum. These usually grow near the surface and may be very abundant in sheltered coves. The pondweed zone, and the succeeding zones as well, may be broad

FIG. 5. Water-lilies (mostly *Castalia odorata*) at Round Pond, North Stonington.

or narrow, according as the bottom of the lake slopes gently or steeply.

In the absence of competition submersed aquatics develop best in shallow water, but as soon as the bottom has been raised high

enough, say within five or six feet of the surface, a higher order of plants—higher in an ecological sense—is able to develop, viz., plants whose leaves float upon the surface (FIG. 5). Most important among these are the water-lilies (*Castalia odorata* and *Nymphaea advena*), from the almost invariable presence of which this phase in the succession is called the WATER-LILY STAGE. As a rule the water-lilies come in with such force that they crowd out most of the submersed aquatics, for the shade produced by their large leaves is so great that nothing can live underneath them. One of the most remarkable structural peculiarities of the water-lilies is seen in their enormous rhizomes. These organs persist year after year, growing in length, sending out roots into the soft muck, and branching at intervals. In *Nymphaea advena* they

FIG. 6. Bulrushes (*Scirpus validus*) at Twin Lakes, Salisbury.

frequently acquire a length of fully eight feet, with a diameter of from two to three inches. When present in abundance they fulfil an important ecological rôle by holding together the loose deposits at the bottom of the lake. This same end is accomplished, though probably less efficiently, by the weak, slender roots and rhizomes of various submersed aquatics. Frequently other plants with floating leaves, such as *Brasenia Schreberi* and *Nymphoides lacunosum*, together with *Potamogeton epihydrus* and similar hetero-

phyllous pondweeds, grow in company with the water-lilies. The duckweeds (*Spirodela* and *Lemna*) and other free-floating forms also commonly occur here, but these, as might be expected, are not definitely restricted to any particular association.

With the continued shoaling of the water it becomes possible for plants to develop which root at the bottom and are partly submerged but whose foliage is raised above the surface of the water. As these increase in number, and as more and more light is intercepted by their aerial photosynthetic organs, species with floating leaves become scarcer and may be completely crowded out. This stage, because of the widespread prominence of the lake bulrush (*Scirpus validus*), the pickerel-weed (*Pontederia cordata*), and the cat-tail (*Typha latifolia*), may be referred to in a general way as the BULRUSH—PICKEREL-WEED—CAT-TAIL STAGE. But quite as often as not only one or at the most two of the character species will be conspicuous in a given lake or pond. Furthermore, where more than one is present, there is a marked tendency for one or another form to dominate locally. It would frequently seem as though the one first to arrive on the scene gained control. For these and other reasons it is convenient to divide this stage into the BULRUSH, the PICKEREL-WEED, and the CAT-TAIL SUBSTAGES. Roughly speaking, these three substages may be regarded as parallels. Thus in a given pond the pickerel-weed may fill the place occupied by the bulrush in another. Yet these substages cannot be regarded as absolute ecological equivalents. This is evidenced by the frequently observed zonal arrangement of the species concerned where two or three are present in the same pond. The cat-tail grows best in water only a few inches deep; the pickerel-weed thrives in water from six inches to nearly two feet deep; while the bulrush, although it develops best in shallow water, can grow in water more than five feet deep. Of the three species, the pickerel-weed (FIG. 7) is the most widely distributed and from an ecological standpoint the most important in Connecticut lakes and ponds. Scarcely a pond is encountered from which this plant is absent, and more often than not it forms a conspicuous fringe in the shoal water along the shore. The bulrush is abundant in many lakes, as at Twin Lakes, Salisbury (FIG. 6), but quite as often as not it is absent or else too poorly developed to be of any ecological significance. The cat-tails are

conspicuous marginal plants in some ponds, but on the whole cat-tail swamps are more characteristic of low flood plains along rivers than of pond margins. Very often a luxuriant development of cat-tails follows upon the removal of the original vegetation from a swampy tract by drought or some similar disaster. In

FIG. 7. Pickerel-weed (*Pontederia cordata*) at Twin Lakes, Salisbury. In the background is an extensive growth of cat-tails and bulrushes.

the subjoined list are given a number of other aquatics with aerial foliage which are found in greater or less abundance growing in shallow water along mucky shores in many lakes and ponds.

Alisma Plantago-aquatica
Cladium mariscoides
Dulichium arundinaceum
Orontium aquaticum
Peltandra virginica
Pontederia cordata
Sagittaria latifolia
Sparganium americanum
var. *androcladum*
Sparganium eurycarpum

To these should perhaps be added the curious AMPHIBIOUS PLANTS, *Proserpinaca palustris*, *Sium cicutaefolium*, and *Cicuta bulbifera*,—species adapted to alternate submergence and emergence.

Most of the plants characteristic of the bulrush—pickerel-weed—cat-tail stage in the lake-swamp succession are provided with more or less extensive rhizome systems, which ramify near the surface of the mucky substratum, thereby tending to make the bottom more solid. The building up of the substratum proceeds much more rapidly as the depth of the water decreases, due partly to the denser plant population of the shoreward zones, as compared with those farther lakeward, and partly to the fact that mechanical tissues, which naturally resist decay, are much more highly developed in plants with aerial organs than in plants which are entirely or for the most part submerged.

Succession in Lake Swamps.—As soon as the bottom of a pond has been built up high enough so that the substratum is exposed during part of the year, aquatic plants begin to give way to terrestrial species. For the sake of convenience, the various stages in the succession up to this point may be referred to collectively as the LAKE SERIES, and the subsequent stages as the SWAMP SERIES. But it is manifestly impossible to draw a sharp line of demarcation between the two; for not only are various species of the bulrush—pickerel-weed—cat-tail association quite characteristic of wet swamps, but it is often easy to observe within this zone, along the shore of a lake, a gradual transition from lake on the one hand to swamp on the other. The bulrush—pickerel-weed—cat-tail stage, then, represents a connecting link between the vegetation of lakes and that of swamps. Swamps which have originated through the filling in of a lake or pond, after the manner above described, may be termed LAKE SWAMPS.

Almost always, in a succession like the one under discussion, the first true land plants to appear in the succession are sedges; hence, the first swamp stage is known as the SEDGE STAGE. To a greater degree than any of the plants that have preceded them, the sedges are equipped with tough rhizomes and copious slender roots, through the interweaving of which the soil is more firmly bound together and converted into a compact turf. By far the commonest, and ecologically the most important, sedge of Connecticut swamps is *Carex stricta*, a species which is readily recognized from its tussock-forming habit (FIG. 8); but frequently other plants with grass-like foliage are equally or even more prominent.

Among these latter, special mention should be made of the spike rush *Eleocharis tenuis*, the grass *Glyceria canadensis*, and the rush *Juncus effusus*. A swamp with predominantly grass-like vegetation is commonly referred to as a MARSH.

The sedge association is much richer in species than any of the

FIG. 8. *Carex stricta* swamp along the Farmington River, Simsbury, showing the tussock-forming habit of this sedge. Picture taken in winter.

preceding stages in the succession, but the plants are still almost exclusively herbaceous. In the subjoined list are given a number of additional vascular species commonly found here.

Acorus Calamus
Asclepias incarnata
*Aspidium Thelypteris**
Aster novi-belgii
Bidens frondosa
*Calamagrostis canadensis**
*Campanula aparinoides**
Carex filiformis
*Carex lurida**
*Carex stipata**
Hypericum virginicum
Impatiens biflora
Iris versicolor
Juncus acuminatus
Juncus canadensis
Lycopus americanus
Lysimachia terrestris
Mimulus ringens
Osmunda regalis
Pogonia ophioglossoides

Cicuta maculata
*Cyperus strigosus**
Epilobium densum
Eriophorum virginicum
*Eupatorium perfoliatum**
*Eupatorium purpureum**
Geum rivale
Ranunculus septentrionalis
Saxifraga pennsylvanica
Scirpus cyperinus
Scutellaria galericulata
*Solidago neglecta**
*Thalictrum polygamum**
*Verbena hastata**
Woodwardia virginica

A *Carex stricta* swamp might well be said to represent a composite habitat. For while the low wet areas between the tussocks afford a suitable substratum for markedly hydrophytic species like *Glyceria canadensis*, *Iris versicolor*, *Lysimachia terrestris*, and *Scirpus cyperinus*, the tussocks, higher and drier than the intervening spaces, offer a foothold for plants like *Aspidium Thelypteris*, *Calamagrostis canadensis*, *Eupatorium purpureum*, and *Verbena hastata*, which thrive best in soil that is not permanently saturated.* In sedge swamps where tussocks of *Carex stricta* are absent, the more mesophytic species, such as *Aspidium Thelypteris* and *Calamagrostis canadensis*, are for the most part restricted to the higher, drier areas, and frequently form a distinct zone around the margin of the swamp.

The sedge stage may be of short or long duration. The building up of the substratum continues, but with less speed than heretofore, due to the accelerated and more thorough oxidation of plant remains which results from exposure to the air. And just as earlier in the series submersed aquatics were shaded out, so to speak, by water-lilies, so in the competition for light the low herbaceous species of the sedge association are destined in the course of time to be superseded as the dominant type of vegetation by shrubs, and these in turn by trees. Many of the plants of the sedge stage persist into the SHRUB STAGE, but they come to occupy a more and more subordinate position. The commonest shrubs of open swamps are the alders (*Alnus rugosa* [FIG. 9] and *Alnus incana*). Indeed, an alderless swamp is a rarity. Along with the alders occur many other shrubs, the most important of which are indicated below.

* All species starred (*) in the above list belong to this latter class. Some of those not starred should perhaps also be included here, but it is very difficult to draw sharp lines.

Cephalanthus occidentalis
Clethra alnifolia
Cornus Amomum
Ilex verticillata
Lyonia ligustrina
Pyrus melanocarpa
Rhododendron viscosum
Rhus vernix
Rosa carolina
Rubus hispidus
Salix discolor
Salix sericea
Spiraea latifolia
Spiraea tomentosa
Vaccinium corymbosum
Viburnum dentatum

FIG. 9. Alders (*Alnus rugosa*) in a swamp, East Haven. View taken in January.

During the early phases of the shrub stage, certain of these shrubs may be more conspicuous than the alders. This is especially true of the *Cephalanthus*, which frequently comes in so early in the succession and occupies the territory invaded in such force that the sedge stage may be almost, if not quite, suppressed. But ultimately, because of its greater height growth, its relative tolerance of shade, and its ability to adapt itself to a wide range of soil conditions, the alder usually becomes the predominant form.

The terminal member of the lake-swamp succession is a

SWAMP FOREST, in which red maple (*Acer rubrum*) is invariably present and more often than not predominates. Commonly growing with it are *Ulmus americana*, *Betula lutea*, and *Fraxinus nigra*. In northern Connecticut the tamarack (*Larix laricina*) is an important swamp tree,* while the coast white cedar (*Chamaecyparis thyoides*) is similarly common in the eastern part of the state. Sometimes other trees, to be mentioned elsewhere (p. 193), occur in lake swamps. Several of the shrubs of open swamps are equally characteristic of wooded swamps, but the herbaceous vegetation is composed very largely of forms not heretofore noted. The following lists of species commonly represented in the undergrowth of swamp forests have been compiled from observations made in more than twenty swamps—exclusive of bogs—in various sections of the state.

WOODY PLANTS

Alnus incana
Alnus rugosa
Amelanchier oblongifolia
Benzoin aestivale
Clethra alnifolia
Cornus Amomum
Ilex verticillata
Lyonia ligustrina
Psedera quinquefolia
Rhododendron maximum†
Rhus Toxicodendron
Rubus hispidus
Rubus triflorus
Sambucus canadensis
Vaccinium corymbosum
Viburnum dentatum
Viburnum Lentago

HERBACEOUS PLANTS

Arisaema triphyllum
Aspidium cristatum
Aspidium Thelypteris
Aster puniceus
Boehmeria cylindrica
Caltha palustris
Carex crinita
Carex stricta
Chrysosplenium americanum
Impatiens biflora
Lobelia cardinalis
Lycopodium lucidulum
Maianthemum canadense
Onoclea sensibilis
Osmunda cinnamomea
Osmunda regalis
Polygonum arifolium
Solidago patula

* *Thuja occidentalis*, one of the characteristic swamp trees farther north, occurs in swamps at Salisbury and Canaan.

† A prominent shrub in many of the *Chamaecyparis* swamps of southeastern Connecticut; found also in a few swamps in Tolland and Litchfield Counties.

Cinna arundinacea
Coptis trifolia
Galium Claytoni
Glyceria Torreyana
Hydrocotyle americana
Symplocarpus foetidus
Thalictrum polygamum
Veratrum viride
Viola cucullata
Viola pallens

Just as was pointed out in connection with *Carex stricta* swamps, the presence in wooded swamps of elevations, formed here by stumps, fallen trunks, roots, etc., makes possible the existence of many species which would be unable to grow in the lower, wetter situations.

The Rôle of Liverworts and Mosses in Lowland Successions.— A short digression may be made at this point to consider the part played in the succession by liverworts and mosses. These are sometimes present in great profusion and may contribute in some measure to the accumulation of humus. In the subaquatic stages of the succession they are often represented by submersed or floating species, such as *Ricciella fluitans*, *Ricciocarpus natans*, *Fontinalis antipyretica* var. *gigantea*, *Fontinalis novae-angliae*, and various forms of *Drepanocladus*. Species of *Sphagnum* may be present here as well as in the earlier swamp stages, but they are often absent and seldom develop as luxuriantly as in the bog succession which will be described presently. Common mosses of open sedge or shrub swamps are *Aulacomnium palustre*, *Bryum ventricosum*, *Philonotis fontana*, *Elodium paludosum*, *Chrysohypnum stellatum*, *Acrocladium cuspidatum*, and *Polytrichum commune*, while the liverworts *Anthoceros laevis* and *Pellia epiphylla* often grow on the perpendicular sides of *Carex stricta* hummocks. In wooded swamps the bryophytes are usually well represented, the following species being perhaps as characteristic as any.

Growing in moist or wet depressions:

Pallavicinia Lyellii
Chiloscyphus rivularis
Sphagnum sp.
Bryum bimum
Mnium punctatum
Mnium cinclidioides
Brachythecium novae-angliae
Calliergon cordifolium
Climacium americanum

Growing on stumps, logs, etc.:

Cephalozia connivens
Bazzania trilobata
Dicranum flagellare
Leucobryum glaucum

Trichocolea tomentella *Fissidens adiantoides*
Dicranum scoparium *Thuidium delicatulum*
Georgia pellucida

The Relation of Swamp Forests to Upland Forests.—In relation to the various plant societies of the lake-swamp series, the swamp forest may be regarded as at least a temporary climax, although it may not always represent the ultimate condition. So long as the ground remains saturated with water throughout a great portion of the year, it is manifestly difficult for a mesophytic flora to develop. Yet very frequently seeds of white pine (*Pinus Strobus*) and other trees from an adjoining upland germinate in a swamp during periods of protracted drought, and once firmly established these are sometimes able to persist in spite of unfavorable soil conditions. Moreover, many upland mesophytes, like *Tsuga canadensis*, *Hamamelis virginiana*, and *Kalmia latifolia*, are commonly present in such swamps, growing on elevations of various kinds. Through the extension of these elevations and the formation of new ones, it is apparent that the general level of the ground may become raised above the zone of saturation, so that mesophytes will become more numerous and the swamp plants correspondingly restricted. In this fashion it is perhaps conceivable that a swamp forest might ultimately be replaced by a forest essentially similar to that which marks the climax of succession on uplands. Theoretically, at least, such a forest represents the culmination of all hydrarch, as well as xerarch, successions in this region. But, parenthetically, it must be conceded that while upland mesophytes undoubtedly tend to become more and more abundant in a lowland forest, and while the tendency for such a forest to approach the upland type is unmistakable, nevertheless, so rapid is decomposition under subaerial conditions, that it is doubtful whether the substratum is ever raised sufficiently to produce a truly mesophytic habitat through the operation of biotic factors alone.

Variations in the Rapidity of Succession in Lakes.—In the foregoing paragraphs it has been shown that there is a tendency for lakes and ponds to become filled in and converted into swamps through the activity of vegetation; but there are great differences in the rate at which this transformation is brought about. Thus

while many ponds have become completely clogged up through the accumulation of muck or peat, there are others in which scarcely any such accumulation would appear to have taken place. And between these two extremes are ponds which exhibit various intermediate degrees of filling. Although the reason for this discrepancy between different ponds is not clear at the present time, it may be due merely to the chance failure of certain plants to become established in the "barren" lakes as soon as in the "fertile" ones. Or it is quite conceivable that a paucity of organic debris may be due to the existence of environmental conditions unfavorable to the luxuriant development of aquatic plants. Certain it is that in ponds with a sandy, gravelly, or rocky bottom, i. e., in ponds where muck or peat has failed to accumulate, the vegetation invariably is sparser than in ponds with a mucky bottom. Particularly is there a dearth here of those species most active in peat formation, such as the larger pondweeds, the water-lilies, the pickerel-weed, and the cat-tail. The vegetation along the sandy or gravelly shores of such a pond is quite different from that along mucky shores. Representative species are *Eriocaulon septangulare*, *Najas flexilis*, and *Lobelia Dortmanna*—growing in shallow water; and *Panicum agrostoides*, *Cyperus dentatus*, *Cyperus strigosus*, *Eleocharis acicularis*, *Juncus brevicaudatus*, *Hypericum mutilum*, *Lysimachia terrestris*, *Gratiola aurea*, and *Gnaphalium uliginosum*—growing on the shore. The factors directly or indirectly responsible for the assumed adverse environmental conditions referred to above may possibly be many. Among those that may enter in are the depth of the water body, the temperature and clearness of the water, the steepness of the shores, the amount of inorganic detritus washed in by streams or otherwise, and the source of water supply. That the degree of protection from or exposure to wind, and the nature of the water currents may also be important factors is suggested by the fact that mucky and sandy shores often occur around the margin of the same lake, the former in the more sheltered, the latter in the more exposed situations. Failure of peat to accumulate might also of course result from any conditions which would promote rapid and complete decomposition; or locally it might be effected through the removal of plant remains by water currents.

Succession in Spring Swamps.—Many swamps have arisen through the filling in of lakes and ponds in the manner described. But a large proportion of Connecticut swamps, as already pointed out (pp. 173–175), owe their origin to the relation between topography and ground water level. The former type of swamp has been referred to as a lake swamp. In contrast to this, the latter type of swamp, by reason of the fact that its existence depends on the presence of seepage or spring water, may be called a seepage or SPRING SWAMP. In a spring swamp there of course are never any truly aquatic stages in the succession. Terrestrial plants are present from the very outset. In a PERMANENT SPRING SWAMP the pioneer association is commonly dominated by sedges, rushes, and grasses, and in general its composition conforms closely to that described for the sedge stage of the lake-swamp succession. But in a PERIODIC SPRING SWAMP the pioneer association may be quite different, both floristically and in its general aspect, from that of a permanent swamp. To be sure, many of the plants characteristic of permanent swamps are represented here also, but on the whole the vegetation is much more mesophytic. Perhaps as good an illustration of a periodic swamp as can be selected is afforded by a LOW MEADOW. Such an area may be very wet in winter and spring, but later in the season the surface layers of the soil usually become relatively dry. As in permanent swamps, the predominant vegetation here is grass-like, but many other herbaceous plants are also conspicuous. The list of species given below may be considered as fairly representative of meadows.

Agrostis alba
Anthoxanthum odoratum
Calamagrostis canadensis
Carex lurida
Carex scoparia
Carex stellulata
Carex stipata
Carex stricta
Castilleja coccinea
Cyperus strigosus
Eupatorium perfoliatum
Eupatorium purpureum
Gentiana crinita
Glyceria nervata
Juncus effusus
Poa pratensis
Rhexia virginica
Rynchospora glomerata
Sanguisorba canadensis
Selaginella apus
Thalictrum polygamum
Verbena hastata
Vernonia noveboracensis
Veronica virginica

Two types of meadows might be distinguished, viz., wet meadows and dry meadows. But the two are not sharply delimited from one another, and it is hardly worth while here to attempt to treat them separately. Owing to their suitability for the growth of grasses, meadows, especially the drier ones, are commonly cultivated and cut over annually for hay, and much of their natural vegetation is thereby eliminated.

The shrub stage in a permanent spring swamp closely approximates the corresponding stage in a lake swamp. The tree stage likewise is quite similar, although some of the trees to be mentioned presently as characteristic of periodic swamps frequently occur here also. In periodic spring swamps the shrub stage in the succession scarcely differs from the shrub stage in permanent spring swamps, except for the scarcity or absence of markedly hydrophytic species like *Cephalanthus*, the greater abundance of the spiraeas and some others of the less hydrophytic shrubs, and the frequent occurrence of mesophytic shrubs. In northwestern Connecticut *Potentilla fruticosa* is very characteristic of such areas. But the tree stage in periodic swamps exhibits noteworthy differences as compared with the tree stage in permanent swamps. For, while any of the trees listed as characteristic of permanent swamps may be found here also, and while here as there red maple and elm may be the predominant species, the forests of periodic swamps are characterized by the presence of a number of trees which require an abundant water supply, but which do not thrive well in a permanently saturated soil. Among these may be mentioned *Tsuga canadensis*, *Carya cordiformis*, *Carpinus caroliniana*, *Quercus bicolor*, *Quercus palustris*, *Liriodendron Tulipifera*, *Nyssa sylvatica*, *Fraxinus pennsylvanica* and *Platanus occidentalis*. The herbaceous vegetation of such swamps includes species which are seldom found in permanent swamps, such as *Erythronium americanum*, *Dentaria diphylla*, and *Panax trifolium*.

As concerns the building up of the substratum to a higher level through the accumulation of plant remains, a state of equilibrium somewhat analogous to that observed in many lakes is very commonly encountered in clayey or sandy swamps where, for various reasons, dead organic matter oxidizes so rapidly that humus fails to collect. Particularly is this true of periodic swamps. In a colder,

more humid climate, peat might develop on such sites; but in Connecticut the mineral soil is frequently covered by little more than the thin mantle of living vegetation and there is little humus. Humus, as is well known, possesses a very high capacity for retaining water, so that a soil rich in humus dries out very slowly. A soil poor in humus may be equally wet in spring, but with the lowering of the water table it dries out much more quickly. Such a swamp, in consequence of the better drainage and aeration of the soil, must necessarily afford a habitat quite different from that in a swamp underlain by a mucky soil. It seems probable, therefore, that the abundance or scarcity of humus may be an important factor in restricting the distribution of the trees mentioned above as characteristic of periodic swamps.

Intermittent Ponds.—From an ecological standpoint these should be classed as swamps rather than ponds, since the seasons when their basins contain water coincide for the most part with the period of vegetative inactivity. During the growing season, except for a short time in spring and early summer, the bottom is merely muddy, and very often in late summer it is quite dry. With the exception of species having more or less amphibious proclivities, like *Proserpinaca palustris*, *Ludvigia palustris*, *Alisma Plantago-aquatica*, *Sium cicutaefolium*, and occasionally *Nymphaea advena*, aquatic plants are absent. Those parts of the bottom which remain longest submerged may be almost destitute of vascular plants and frequently support a rich growth of algae, like *Vaucheria* and *Botrydium*, or of bryophytes, like *Riccia*, *Fossombronia*, and *Ephemerum*. On parts of the bottom which are exposed during a somewhat longer period commonly grow *Eleocharis acicularis*, *Hypericum virginicum*, *Lysimachia terrestris*, etc.; while very often there is a rank growth of various species of *Bidens* and *Polygonum*, together with other rapid-growing, fall-flowering annuals. Fringing the margin of the "pond" may occur almost any of the herbs, shrubs, or trees characteristic of swamps. It should be noted, perhaps, that *Cephalanthus* is an almost omnipresent marginal shrub.

PLANTS IN RELATION TO THE FORMATION OF MARL

There is one other important phase of plant activity in connection with the filling in of lakes and ponds to which no ref-

erence has yet been made, namely, the formation of marl. Marl deposits are always associated with calcareous regions, and in Connecticut are confined to the limestone areas in the western part of the state. At Twin Lakes, Salisbury, there are quite extensive deposits, estimated in places to exceed a hundred feet in depth, and there are similar deposits near Danbury and elsewhere. Chemically, pure marl contains about ninety-five per cent. of calcium carbonate. Formerly such deposits were supposed either to represent shell remains, or else to have originated through mechanical sedimentation or chemical precipitation from calcium-containing waters.* But while the presence in marl beds of *Chara* and other plant "fossils" had frequently caused comment, and although it is a common observation that in lakes where marl is being deposited, submersed aquatic plants are usually coated with a thin crust of calcium carbonate, it remained for Davis† to demonstrate the important rôle played by plants, particularly by the alga *Chara*, in marl formation.

In a general way it may be asserted that plants are able to bring about the formation of marl by causing the precipitation of various calcium salts which may occur dissolved in the waters of lakes and ponds. Two methods by which plants may effect this result are easily conceived. (1) The abstraction of carbon dioxide from water in which calcium is present in excess, held in solution by free carbon dioxide, would cause the precipitation of the calcium salts. (2) The combination of the oxygen liberated by plants with easily soluble salts like calcium bicarbonate, thereby converting them into less soluble salts like calcium carbonate, would result in precipitation. The existence of still a third, and possibly even more effective, method of calcium concentration has been pretty conclusively demonstrated by Davis in the case of *Chara*. (3) The calcium accumulates in the cells of this plant in the form of calcium succinate, one of the few water-soluble salts of calcium. Later on, although just how is not as yet wholly understood, the dissolved salts are excreted and deposited in

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* For further discussion, see Hale, D. J., Theories of origin of bog lime or marl. Geol. Surv. Michigan 8[3]: 41–64. 1903.

† A contribution to the natural history of marl. Geol. Surv. Michigan 8[1]: 65–96. 1903. Also earlier papers in Journal of Geology.

an insoluble form on the surfaces of the cells. At Twin Lakes this alga is extremely abundant, more so than in any other lake or pond in the state, so far as the writer's observations have extended. Here, not only *Chara*, but the leaves and stems of *Najas*, *Elodea*, and various species of *Potamogeton* are incrusted by a thin, white, flaky deposit of marl. Some of the blue green algae, notably *Zonotrichia*, are likewise instrumental in causing marl formation.* Because of the inability of most of the plants active in its precipitation to survive in competition with shallow water species, the production of marl is largely restricted to the deeper parts of lakes.

THE FLOATING MAT

Occurrence and Importance of the Floating Mat.—In an earlier paragraph the writer has alluded to the manner in which the shallow-water zones of vegetation in a lake tend to push out from the shore and to encroach upon the deeper areas. In most lakes and

FIG. 10. Diagrammatic vertical section through the marginal portion of a lake which is being filled in through the intervention of a floating mat, showing the usual succession of plant societies. Sequence of Zones: 1. Pondweed Zone; 2. Water-lily Zone; 3. *Decodon* Zone; 4. Cassandra—*Sphagnum* Zone; 5. Cassandra—*Sphagnum*—Sedge—Low Spruce Zone; 6. Tall Shrub Zone; 7. Bog Forest. F = Marginal Ditch or "Fosse".

* For detailed discussion of the relation of *Chara* and *Zonotrichia* to marl formation, see Davis, 1903, *op. cit.*, especially pp. 87–92.

ponds where rapid peat accumulation is taking place the filling in of the deeper waters is brought about in this manner. Very often the growth of certain marginal swamp plants is so vigorous as to give rise to a raft-like zone of vegetation which spreads out from the shore over the surface of the water, and which is commonly referred to as a FLOATING MAT (FIG. 10). There will be described next, then, the manner in which this mat is developed, together with the succession of plant associations which accompanies the process. And since in Connecticut the floating mat succession is commonly associated with bogs, a type of swamp not yet treated, the two will be considered together, i. e., the succession is assumed to culminate in the formation of a bog.

Mat Formation due to Sedges.—The lake stages in such a succession are identical with those already described. There may thus appear, in order, submersed aquatics, aquatics with floating leaves, and aquatics with aerial foliage; but, due to the encroachment of the mat, these stages may be quite abbreviated, and one or all may be eliminated. It is in the transition from lake to swamp that the floating mat comes into play. According to the conception which has been widely circulated, especially in geological literature previous to 1907, this mat is formed in the following manner. "Certain mosses, particularly those of the genus *Sphagnum*, have a habit of growing out on the water surface and forming a mat of intertwined stems connected with the shore. At this stage the lake is an open water body with a border of vegetation floating near the rim. Gradually this rim of moss creeps toward the center of the pond until it is completely closed in and covered over with a layer of vegetation. The lake is now a swamp; and such a swamp, with a floating layer of aquatic plants, is known as a 'quaking bog'; it is possible in some cases to walk across an old lake on a mat of vegetation while the water remains below. These mosses have a habit of growing at the top while the old stems are dying below, and the rotted fragments drop to the bottom of the pond and help to fill it up."*

Except for the stress laid on the rôle of *Sphagnum* and other mosses, the description above quoted portrays the origin and behavior of the floating mat fairly accurately; and for cold,

* Rice, W. N., and Gregory, H. E., *op. cit.*, p. 249.

humid regions like parts of eastern Canada the importance of the mosses would hardly be overestimated. But, as indicated by Transeau* and conclusively proved by Davis,† in milder, less humid regions the mosses play at best a very subsidiary part in mat formation. In Michigan, according to these authorities, the most important mat-forming plants are the sedges, particularly *Carex filiformis*. This species is capable of spreading rapidly by means of rhizomes. As pointed out by Davis, these subterranean or subaquatic stems will often grow horizontally a foot or more in length during a single season, producing at the nodes an abundance of tough, slender roots, and bearing at their tips terminal buds "from which new plants rise to send out in turn a new series of horizontal stems. When conditions are un-

FIG. 11. Floating sedge mat at Twin Lakes. The plants along the margin of the mat are bulrushes.

favorable for the rhizomes to grow outward into open water, they sometimes grow diagonally downward over the edge of the mat, and thus the mat is strengthened as well as extended by the growth of the plant." On account of its low specific gravity, the tangle of roots and rhizomes thus produced floats on the surface of the

* Bot. Gaz. 40: 363. 1906.

† 1907, *loc. cit.*, pp. 135–138.

water like a raft. Along the western shore of one of the Twin Lakes is a beautiful example of a floating mat which thus owes its origin to *Carex filiformis* (FIG. 11); and similar mats are frequently encountered in other sections of the state. Toward its lakeward margin such a mat is usually thin, but farther away from the edge it reaches a thickness of two feet or more and becomes firm enough to support considerable weight. For some distance from its outer margin, in cases where it is typically developed, the mat is actually floating and is underlain by clear water. But in proceeding from the margin shoreward the water underneath is "found to become more and more full of finely divided matter until, at a variable distance from the water's edge, the deposit is nearly solid and the mat no longer floats".* The filling up of the open water underneath, and the ultimate grounding of the mat is brought about very largely in the manner already suggested, namely, by the dropping down of debris from the lower surface of the raft. Often, owing to local conditions, the mat grows outward from the shore so slowly that the water beneath the floating substratum becomes filled out to its very margin. By the time the mat has grounded, if not before, shrubs have asserted themselves as the controlling element of surface vegetation; and these in turn, as in the lake-swamp succession already described, ultimately give way to trees.

Mat Formation due to Decodon.—But, on the whole, in Connecticut the sedges are overshadowed as pioneer mat formers by certain shrubs, notably *Decodon verticillatus*. The manner in which this latter shrub not only brings about the formation of a floating mat but accelerates the upbuilding of the surface as well, has been admirably described by Davis.† Growing at the water's edge it sends up slender, arching stems, many of which reach out over the open lake, curving gracefully downward toward their tips until they enter the water (FIG. 12). Here the stem becomes greatly swollen, due to the formation of aerenchyma, and develops numerous adventitious roots. The aerial part of the plant is herbaceous and dies at the end of the growing season. But the swollen, submerged portion of the stem becomes woody and perennial, lives through the winter, moored in place, as it were, by the other-

* Davis, 1907, *loc. cit.*, p. 138.

† 1907, *loc. cit.*, pp. 151, 152, 204–206.

wise functionless, dead aerial part of the stem, and the following season sends up a fresh series of aerial stems. Some of these grow outward over the open water, thus extending the margin of the mat lakeward; others reach shoreward, thereby more effectually uniting the newer with the older portions of the mat; while yet others grow out in lateral directions, in this way binding together

FIG. 12. *Decodon verticillatus* advancing into open water along margin of a pond, Southington. View taken in winter.

more firmly the integral parts of the still rudimentary structure. At this stage the mat is little more than a framework, consisting of a loose aggregation of the *Decodon* plants. But upon the stools formed by the *Decodon*, and about its roots, other plants soon appear, and as these increase in number, reaching across from one stool to another, the skeleton gradually becomes transformed into a continuous, compact body.

Importance of Other Plants in Mat Formation.—Often one of the earliest plants to appear among the *Decodon* stools is the *Sphagnum*. But while this moss may act as a space filler, it adds little to the strength of the mat; for its stems, weak and nearly

devoid of mechanical tissue, could hardly be expected to possess any great degree of tensile strength. Moreover, as a rule, *Sphagnum* does not develop in any abundance until a later stage in the succession. Various species of *Drepanocladus* may also grow in the water about the *Decodon* roots, but their rôle in mat formation is inconsequential. As in the case of the sedge mat earlier described, it is the vascular plants with their tough stems and roots, particularly species like the cranberry (*Vaccinium macrocarpon*) and cassandra (*Chamaedaphne calyculata*), which are primarily responsible for the increase in the continuity and compactness of the substratum. *Decodon* is primarily a pioneer, and in competition with other plants is speedily exterminated. When present, it usually occupies a zone from six to a dozen feet wide along the water front, but, except for scattered specimens, is absent elsewhere. Inside the *Decodon* zone there is commonly a zone dominated by cassandra, along with which, in increasing abundance, grows the *Sphagnum*.

It might naturally be anticipated that where the pioneer plants are shrubs, the sedges would be eliminated from the succession, but this is rarely the case. Almost always sedges and other herbaceous bog plants occur in among the shrubs, and quite frequently the cassandra zone is bordered on the landward side by a more or less continuous zone in which the dominant plants are *Sphagnum*, cranberries, and such sedges as *Rynchospora alba* and *Eriophorum virginicum*. The exact explanation of this last mentioned phase in the succession is puzzling. It seems to represent a RETROGRESSIVE CONDITION due to some disturbance which has caused the disappearance of the cassandra and has thus created an opening for a more primitive association to become established. Such a result might be effected either by a sinking of the mat, or by a temporary elevation of the water level which might flood the grounded portions of the mat, and, if of sufficient duration, might cause the death of the cassandra. Proceeding farther landward from this zone, shrubs once more assume control, and under normal conditions, as in other cases, trees ultimately become the predominating element of the vegetation.

There are other ways in which the formation of a floating mat may be inaugurated. At Bingham Pond, Salisbury (FIG. 14), and

elsewhere (FIG. 15) the plant which fringes the water's edge and forms the skeleton for the advancing mat is the cassandra. The extension outward into the open water is slow when dependent on this plant, and the mat is usually thick and firm out to its very edge. At Bailey Pond, Voluntown, is a remarkable submersed mat, some ten feet wide, composed entirely of the rhizomes of the fern *Woodwardia virginica*. Floating logs, sticks and similar debris doubtless contribute their quota to the formation of the raft; while sometimes great patches of rhizome-permeated muck break loose from the bottom of a pond, rise to its surface, and furnish a substratum favorable for the rapid spread of sedges and other mat forming plants.*

ECOLOGICAL RELATIONS, ORIGIN, AND DISTRIBUTION OF BOGS

Bogs Compared with Ordinary Swamps.—A BOG may be defined as a fresh water swamp characterized, especially in the shrub stage, by an abundance of xerophytic plants. It might well be designated a XEROPHYTIC SWAMP. In Connecticut, so far as known, bogs are always developed in morainal depressions. This type of swamp, by reason of its unique vegetation, the ecological problems involved, and the economic value of the frequently underlying peat deposits, has probably received more attention at the hands of investigators than all other swamp types put together. In comparing the plant associations encountered in a lake-bog succession with those in an ordinary lake-swamp series, the first appreciable differences are perceived in the sedge stage, while the departure of the two types from one another becomes very pronounced in the shrub and tree stages. From a floristic standpoint, Connecticut bog vegetation is unique because of the predominance of ericaceous shrubs, the prevalence of black spruce (*Picea mariana*) and other boreal species otherwise absent from this region, the presence of bizarre forms like the pitcher plant (*Sarracenia purpurea*) and the sundews (*Drosera rotundifolia* and *Drosera longifolia*), and the usually luxuriant development of *Sphagna*. Ecologically, the most interesting problems relate to the phenomenon of bog xerophytism.

* Such masses often rise to the surface during the summer, only to sink to the bottom again in the fall. In this connection see S. Powers's paper on "Floating Islands", Bull. Geog. Soc. Philadelphia **12**: 1–26. *f.* 1–9. 1914.

Succession of Plant Societies in Bogs.—As suggested in earlier paragraphs, succession in bogs, in Connecticut at any rate, is usually associated with floating mat formation, and several of the phenomena of a bog succession have already been discussed under that head. Where a bog still borders an open body of water the various plant associations mentioned in connection with the floating mat succession are often clearly distinguishable. But quite as often, especially where the bog occupies a basin that has become completely filled in (FIG. 13), the three associations are

FIG. 13. Spruce bog, Willington. *Picea mariana* and *Chamaedaphne calyculata* the dominant forms; small, scattered specimens of *Pinus rigida* in the foreground.

more or less completely merged into one, i. e., they are telescoped. The shrubs here, along with *Sphagnum*, tend to form elevated patches; sedges, with *Sphagnum*, dominate on the intervening lower ground; while the spruces—seldom over fifteen feet high, mostly under eight, and commonly less than four—for the most part grow scattered about among the shrubs, here and there developing colonies of sufficient size and density to shade out the more in-

tolerant undergrowth. In a bog of this sort the more depressed, wetter spots may be occupied largely by various bryophytes, e. g., *Cephalozia fluitans*, *Mylia anomala*, *Scapania irrigua*, *Aulacomnium palustre*, *Acrocladium cuspidatum*, *Drepanocladus fluitans*, and certain species of *Sphagnum*. The following herbaceous seed plants also commonly occur in like situations.

Arethusa bulbosa
Calla palustris
Drosera longifolia
Drosera rotundifolia
Dulichium arundinaceum
Eleocharis palustris
Hypericum virginicum
Menyanthes trifoliata
Rynchospora alba
Scheuchzeria palustris
Smilacina trifolia
Utricularia cornuta
Xyris caroliniana

The vegetation of these depressions may represent a relict of a primitive stage in the succession, but it seems more likely that it represents a retrogressive phase like the one already described. Characteristic also of open bogs, but mostly growing in less wet places, are the following herbaceous species.

Asclepias incarnata
Aspidium Thelypteris
Calamagrostis canadensis
Carex rostrata
Carex trisperma
var. *Billingsii*
Epilobium sp.
Eriophorum sp.
Habenaria blephariglottis
Lysimachia terrestris
Pogonia ophioglossoides
Woodwardia virginica

From these lists are omitted purposely a number of species, like *Carex pauciflora* and *Carex paupercula*, which are peculiar to bogs but which have been recorded from only one or two localities in the state.

The shrubs of open bogs may conveniently be divided into two groups, somewhat as follows.

FIRST GROUP

Andromeda glaucophylla
Chamaedaphne calyculata
Chiogenes hispidula
Gaultheria procumbens
Gaylussacia dumosa
var. *Bigeloviana**
Gaylussacia baccata
Kalmia angustifolia
Kalmia polifolia
Ledum groenlandicum
Vaccinium macrocarpon
Vaccinium Oxycoccus

* This northern variety of *Gaylussacia dumosa* was described by Fernald in Rhodora 13: 95–99. 1911.

SECOND GROUP

Alnus rugosa (or *A. incana*)	*Pyrus melanocarpa*
Amelanchier oblongifolia	*Rhododendron viscosum*
Ilex verticillata	*Rhus vernix*
Myrica carolinensis	*Vaccinium corymbosum*
Nemopanthus mucronata	*Viburnum cassinoides*

Most of the shrubs peculiar to bogs are included in the first group. It will be noted that all of the species there listed are ericaceous, and that practically all of them are distinctly northern in their range. The shrubs in the second group are not so strictly confined to bogs, but, with one or two exceptions, are frequent or common in swamps of the ordinary type. The majority of them are equally well developed far to the south. It should be added that the species in the first group are comparatively low growing—mostly less than three feet high when mature—while those in the second group average well above three feet. In studying their distribution in an open bog, it is noticeable that the lower shrubs comprising the first group are pretty uniformly distributed throughout, while the taller shrubs which comprise the second group are best developed toward the landward margin, or in slightly elevated situations. In the case of a bog bordering an open pond, as at Bingham Pond (FIG. 14), there are usually four rather definite bands of woody vegetation, paralleling the water's edge: first, a zone of low shrubs; then, a zone of low shrubs intermixed with young spruces and tamaracks;* next, a zone of taller shrubs along with older trees; and finally, farthest removed from the pond, a zone of large spruces together with some of the more tolerant of the taller shrubs. Undoubtedly some correlation exists between the position usually occupied by shrubs of the second group in bogs and the fact that most of them quite commonly occur in swamps of the ordinary type, a correlation which almost certainly relates to soil aeration and drainage. There very likely is also some connection between this local distribution of these plants in bogs and swamps and their geographic distribution.

Sphagnum and its Relations.—Occasionally, as for example at Twin Lakes, a bog is encountered from which apparently *Sphagnum* is entirely missing. In the particular case cited the bog is under-

* Between this and the next shrub zone is frequently interpolated the *Sphagnum*—cranberry—sedge zone already mentioned.

lain by marl, and since *Sphagnum* is reputedly calciphobous, it was at first thought that here, at least, its absence could be easily accounted for. But in a nearby swamp which likewise overlies a calcareous subsoil *Sphagnum* is abundant. Similar observations by Davis* in Michigan, together with the experimental evidence advanced by Transeau and Weber† would make it appear highly improbable that the presence or absence of *Sphagnum* can be correlated with the presence or absence of lime. As a rule, in the floating mat succession, *Sphagnum* seldom precedes the shrubs and sedges, except to an inconsequential degree. There are a few ponds in southeastern Connecticut where *Sphagnum macrophyllum*, a remarkable southern coastal-plain species with leaves fully half an inch long, constitutes an important part of the free-floating vegetation. But this condition is exceptional. In a bog the *Sphagnum* usually appears first as a superficial layer growing on the surface of the shrub or sedge mat; but once established it often develops so rapidly and luxuriantly as to exert a profound influence on the character of the bog vegetation.‡ Growing upward in dense masses around and among the stems of various shrubs, etc., this plant commonly forms cushions which sometimes rise as much as two feet above the original water level. Antecedent plants which are unable to accommodate themselves to this change in environmental conditions are gradually eliminated.

Broadly speaking, the ability of a plant to exist in a bed of rapidly growing *Sphagnum* may be said to depend on its ability to keep pace with the upward growth of the moss. The necessity of keeping the foliage above the surface of the substratum is too obvious to require more than passing mention. But it seems very likely that it is equally important that the roots of the plant be kept above the zone of permanent saturation. For as the *Sphagnum* plants grow upward, dying away below, the lower part of the cushions becomes more and more compact and, due largely to the well-known capacity of *Sphagnum* stems and leaves for sucking in water, acting like a sponge, it becomes completely saturated. As the *Sphagnum* cushions increase in height, then,

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* 1907, *loc. cit.*, p. 276.

† See Transeau, 1906, *loc. cit.*, p. 32.

‡ In this connection see also W. S. Cooper's discussion of the behavior of *Sphagnum* in Isle Royale bogs. Bot. Gaz. **55**: 200–206. 1912.

the water level rises correspondingly, with the result that the roots of plants originally growing on the mat's surface are submerged. The characteristic plants of SPHAGNUM BOGS are those which are able in some way to develop root systems above this zone of saturation. Species like *Aspidium Thelypteris* and many sedges accomplish this result through the upward growth of their rhizomes. Sprawling vines like *Chiogenes* and *Vaccinium macrocarpon* similarly have little difficulty in establishing fresh footholds from time to time. The pitcher plant possesses little power of stem elongation and individual plants are buried quite rapidly, but like some other bog plants it reproduces itself with sufficient rapidity by means of seeds to enable it to hold its own. Among the shrubs the most successful species are those which freely produce adventitious roots from the old upright stems above the zone of permanent saturation. Among others, *Chamaedaphne*, *Kalmia polifolia*, and *Ledum* are noteworthy in this respect. In a specimen of *Ledum*, for example, which the writer collected in a *Sphagnum* bog at Norfolk, the leafy shoot rose but eight inches above the surface, the remaining part of the stem, more than three feet long, being imbedded in the moss. Adventitious roots had developed throughout the length of the stem, those on the first foot of stem below the surface being vigorous and obviously the only ones functional at the time of collection. It is interesting to note in this connection that Cowles,* in his study of the vegetation on the sand dunes of Lake Michigan, found that the ability of many woody plants to withstand burial by sand likewise depends on their power of stem elongation plus the development of adventitious roots. The upward growth of a *Sphagnum* cushion proceeds most rapidly at first; eventually it attains a height where the balance between increasing evaporation and decreasing water supply is such that further upward growth is no longer possible. When this stage is reached species of the lichen *Cladonia* and relatively xerophytic mosses like *Polytrichum commune* and *Hypnum Schreberi* frequently establish themselves on top of the *Sphagnum* cushions.

The Significance of the Marginal Ditch.—Separating the bog from the adjoining upland, more often than not, there is a broad,

* Bot. Gaz. 27: 384. 1899.

open ditch, or fosse, which at certain seasons of the year may be filled with water to a depth of one or two feet. This ditch is a widespread feature of bogs and its significance is not yet wholly clear. But of the various explanations offered, that suggested by Davis* seems to the writer most plausible. Davis attributes the formation of the fosse to "the fluctuation of the water level through rather brief intervals and the constant recurrence of these fluctuations. These are attendant upon the variations in the rainfall, and the water level in the lakes and depressions may vary one, two, or more feet every few years, and may remain at the low water stage for several years in succession. . . . It is also a matter of observation that, during dry times, the water does disappear from these marginal ditches for long periods during the summer and autumn, the bottoms becoming quite dry, and this has the effect of destroying much of the hydrophytic vegetation which has established itself and also of thoroughly decomposing and disintegrating the organic matter which has accumulated during periods of high water." In this way the surface is lowered "below that of the area directly above the zone of permanent water, which, being covered by a thicker layer of vegetable debris, is kept wet by the upward capillary movement of the water from below its surface."

The Tree Stage in Bogs.—The most distinctive feature of the tree stage in Connecticut bogs, considered collectively, is the presence of the black spruce. Commonly associated with this, and sometimes forming considerable forests in the older, better drained portions of the bog, grows the tamarack. The tamarack is not so tolerant of shade as the black spruce, but its more rapid and greater height growth enable it to maintain its own in the competition for light. More or less extensive tamarack forests formerly occurred in bogs at New Fairfield, Suffield, and elsewhere. Due to the rather open character of such forests, and the slight shade produced by the tamarack, the spruce, together with much of the undergrowth present in the adjoining parts of the open bog persists here. The black spruce itself seldom forms a stand of sufficient height and density to merit the title of forest; but in the cool highlands of northwestern Connecticut, about Bingham Pond

* 1907, *loc. cit.*, p. 151. For references to other explanations see Cooper, *loc. cit.*, p. 203.

(FIG. 14), there is a magnificent forest of spruce. Here, however, the black spruce of the opener parts of the bog seems to have been largely superseded by the red spruce (*Picea rubra*), a species which attains a much larger size, but which is absent from most sections of the state.* Along with the spruce in this Bingham Pond forest

FIG. 14. Spruce bog surrounding Bingham Pond, Salisbury. Behind the marginal fringe of *Chamaedaphne*, etc., is seen the bog forest, largely composed of *Picea rubra*. Water of pond somewhat lowered through artificial drainage.

grow the mountain ash (*Pyrus americana*), a species sometimes found in bogs in other sections of the state, and commonly in bogs farther north. There are also scattered yellow birches, but the spruce predominates, casting a shade so dense as to effectually exclude nearly all of the herbs and shrubs characteristic of the open bog. The ground beneath in many places is carpeted with various mosses and liverworts, e. g., *Bazzania trilobata*, *Dicranum scoparium*, *Dicranum undulatum*, *Leucobryum glaucum*, *Hylocomium splendens*, *Ptilium Crista-castrensis*, *Stereodon imponens*,

* The correctness of the identification of these trees as *Picea rubra* is possibly open to question. At the time this forest was studied, the writer assumed them to be *Picea mariana*. Since then, however, study of these two species in the Canadian woods has led to the conviction that they must be *Picea rubra*, an opinion which was first expressed and has recently been reaffirmed by Dr. C. A. Davis. These trees also grow on the mountain slopes in the vicinity of the pond.

Hypnum Schreberi, and *Georgia pellucida*, and there are occasional patches of *Sphagnum*. Characteristic herbaceous plants here are *Aralia nudicaulis*, *Clintonia borealis*, *Coptis trifolia*, *Cypripedium acaule*, and *Maianthemum canadense;* these grow for the most part in the least shaded spots. The commonest shrub is *Kalmia latifolia*.

In eastern Connecticut, the coast white cedar largely supplants the black spruce as the characteristic bog conifer, while throughout the state bogs are frequently encountered from which conifers are entirely absent. At Berlin, for example, there is a large bog, perhaps sixteen acres in extent, whose surface, except for a peripheral band of red maple and taller shrubs, is entirely covered with heaths and *Sphagnum*. In Beaver Swamp, a bog within the New Haven city limits, red maple is likewise the only arborescent species present. The omnipresence of this latter tree in swamps of the ordinary type has already been commented on. This observation may be extended to include bogs; but here, except where the original vegetation has been disturbed, it is usually conspicuous only toward the landward margin.

The Problem of Bog Xerophytism.—In attempting to explain the differences between bog vegetation and that of ordinary swamps, two sets of factors must be taken into account, namely, factors which are active at the present time, and factors which have operated during the past. The immediate effect of the first set is seen in the phenomenon of bog xerophytism; the effect of the second set may be reflected in the restriction to bogs of so many boreal plants. That, despite their physical wetness, the soil conditions in bogs are conducive to xerophytism has long been recognized. This xerophytism is evidenced by the fact that many of the commonest bog plants are likewise characteristic of habitats which are physically dry. Thus, in Connecticut, *Gaylussacia baccata* and *Gaultheria procumbens* grow abundantly in dry woods and clearings; *Kalmia angustifolia* and *Myrica carolinensis* flourish on dry, open hillsides; while *Pyrus melanocarpa* and *Vaccinium corymbosum* are among the commonest shrubs on exposed, rocky ledges along the coast. Moreover, many of the more distinctive bog plants, in contrast with most plants of ordinary swamps, exhibit structural peculiarities which are char-

acteristic of xerophytes; while analogous xerophytic modifications may frequently be observed in the leaves of bog-grown individuals of such a species as *Alnus rugosa*, which occurs in both types of swamps. The xerophytic peculiarities of the leaves of bog evergreens, e. g., the cassandra, however, need not necessarily be attributed to the nature of the habitat, but may rather, to a certain extent at any rate, be associated with protection from excessive transpiration during the winter.*

Many theories have been advanced with a view to explaining the condition of physiological xerophytism prevalent in bogs. It has been variously ascribed to the acidity of the soil, to the low temperature of the soil, to the insufficient aeration of the soil, and to the accumulation in the soil of root excretions or various toxic substances.† Doubtless there are still other factors whose effect may be equally potent. For example, in view of the low diffusion properties of humus soils, which to a great extent would exclude salts derived from the subjacent mineral soil, together with the only partial decomposition of vegetable remains in bogs, it is conceivable that an actual scarcity in the bog substratum of the requisite mineral elements in form suitable for absorption and assimilation by most plants may be a factor of some significance. Indirectly, the topographic relations of bogs are considered important. Bogs usually develop in undrained or poorly drained depressions, and almost invariably in connection with a water body of considerable depth. In Salisbury, Norfolk, Kent, Litchfield, and elsewhere there are bog-bordered lakes, but in many cases, the depressions occupied by bogs, although quite deep, are only a few acres in extent. In two small bogs at Southington, for example, the writer was unable to touch bottom with a twenty-five foot peat sampler. One of these bogs is shown in FIG. 15. That the lack of drainage in such basins would tend to promote soil acidity, poor aeration, and the accumulation of deleterious substances seems obvious, while their depth would favor low soil temperatures. Regarding the relative importance of these different factors, how-

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* See Gates, F. C. Winter as a factor in the xerophily of certain evergreen plants. Bot. Gaz. **57**: 445–489. *f. 1–12*. 1914.

† For references to the literature relating to these various theories, see Dachnowski, Bot. Gaz. **52**: 1–3. 1911.

ever, no definite statement can yet be made, although it seems more than likely that the observed conditions may result from a combination of several causes. Whatever the direct cause or causes, the prevailing consensus of opinion among ecologists seems to be that their ultimate effect on the plants concerned is such as

FIG. 15. Spruce bog surrounding a small pond, Southington. Marginal fringe of *Chamaedaphne*, with small black spruces and tall shrubs in the rear. On the snow-covered hill in the background can be made out oaks, chestnut, and red cedar.

either to directly hinder absorption, or else to indirectly reduce it by retarding root development.

The Origin of the Northern Flora in Bogs.—While soil conditions satisfactorily account for the phenomenon of bog xerophytism, it is doubtful whether the remarkable assemblage of northern plants found in bogs is to be explained on this basis alone. In considering this problem some years ago, Transeau* arrived at the conclusion that the explanation must be sought in the physiographic history of the areas concerned. According to his con-

* On the geographic distribution and ecological relations of the bog plant societies of North America. Bot. Gaz. **36**: 401–420. *f.* 1–3. 1903; also 1906, *loc. cit.*

ception: "Where the habitat dates back to Pleistocene times and has remained undisturbed, we find today the bog flora. Where the habitat is of recent origin or has been recently disturbed, we find the swamp flora, or mixtures of swamp and bog species." The plausibility of some such explanation for the presence of northern plants in bogs was re-impressed on the writer during the past summer in the course of ecological investigations conducted on Cape Breton Island. There the bog is the common swamp type, and its vegetation seems wholly in harmony with the forests of fir and spruce that clothe the surrounding uplands; the transition from one to the other is gradual; bog vegetation there is much less restricted than here, as is evidenced by the fact that species which in Connecticut are confined to bogs commonly occur there in shallow depressions along streams, while a much larger proportion of bog species grow on the uplands. Yet notwithstanding the marked contrast in the upland vegetation there and here, the resemblance of bog vegetation in the two regions, not only in general aspect but in specific composition, particularly with reference to sedges, ericaceous shrubs, and trees, is remarkable. Here in Connecticut, however, in contrast to the conditions farther north, the bog is a comparatively rare swamp type, and its vegetation seems utterly out of harmony with the deciduous forests of the surrounding uplands; the transition from one to the other is abrupt, while the characteristic northern bog plants for the most part are restricted to bogs.

In the first paper of the present series* the writer suggested the probability that subsequent upon the final retreat of the continental ice sheet, this region for a long time was populated by northern types of vegetation which, having originally been forced southward by the advance of the glaciers, once more migrated northward in the wake of the retreating ice-front. During the time that has elapsed since the recession of the ice, variously estimated at from 20,000 to more than 50,000 years, there undoubtedly has been a gradual readjustment of the climate, and as a result of this, coupled with the invasion of plants from the south and west, our present vegetation has been evolved. In the historical sequence of vegetative formations which have occupied

* Torreya 13: 93. 1913.

the region under discussion during this period, there doubtless have been represented many of the types of vegetation which at the present time are characteristic of regions farther north. Thus the first vegetation to seize upon the freshly exposed land areas may have been quite similar to the tundra formation which today is restricted to the far north. But the dominance of the tundra must have been relatively ephemeral, for except as it may possibly be represented by isolated species of plants, all traces of it have vanished. Following the tundra there presumably was gradually developed a type of vegetation essentially similar to that which today prevails in northern Maine and in the eastern maritime provinces of Canada. Forests of fir and spruce dominated the landscape. At this time, associated perhaps with a moister, cooler climate, the relationship between lowland and upland vegetation must have been quite similar to what it now is farther north. The bog was a common swamp type, and bog plants were by no means confined to bogs. Just how long this condition prevailed is of course largely a matter of speculation. It is perhaps significant, however, that red spruce and fir still persist as upland species in certain localities in northwestern Connecticut, while the southern boundaries of the great fir and spruce forests of Maine are scarcely two hundred miles north of Long Island Sound. From such facts as this it seems probable that within very recent geological time spruce and fir comprised an important element in the forests of this region. When in their northward march the deciduous trees, which at present predominate the forests of the state, commenced to invade this region, they doubtless became established first in the more favorable sites, so that there thus arose a mixture of coniferous and deciduous types of forest. Such conditions actually exist in the north-woods today. In northern Cape Breton Island, for example, forests of beech (*Fagus grandifolia*), sugar maple (*Acer saccharum*), and yellow birch (*Betula lutea*), together with hemlock (*Tsuga canadensis*), almost identical in aspect with virgin forests in northern Connecticut,* occupy the intervales and many other favorable sites; elsewhere fir and spruce predominate. Such a condition may have continued in Connecticut for a very long period. Ultimately, however, perhaps to the accompaniment of

* Described by the writer in Torreya 13: 199–215. 1913.

climatic changes, the more vigorous southern species gained the upper hand, so that spruce and fir have largely been eliminated from this region.

In the present connection the discussion set forth in the preceding paragraph is of course significant only as it bears on the question as to the origin of Connecticut bog vegetation. In the opinion of the writer the answer to this question may be stated somewhat as follows. From the above discussion it seems fairly certain that within very recent geological time the vegetation of this region has been quite like that of northern Cape Breton Island today, i. e., the upland forests included a mixture of broad-leaf and coniferous forest types and bog vegetation was common in all swamps. As the conquest of the region by the southern types of vegetation progressed further, the coniferous type was first vanquished on the uplands, since here environmental conditions proved most congenial to the invaders. It was not, perhaps, until these uplands had become pretty completely occupied that the last strongholds of the northern plants—the swamps—were stormed.* The northern vegetation in spring swamps was first to succumb, since soil conditions here proved quite suitable for certain of the southern invaders. Similarly the northern vegetation in most lake swamps was gradually replaced by southern types. But the conquest of some of these lake swamps proved a difficult undertaking, owing to the peculiar soil conditions which have been described in connection with the discussion of bog xerophytism. For to these adverse soil conditions the northern defenders proved singularly well adapted—so well adapted, in fact, that many of these isolated plant communities still survive the siege. A bog, therefore, is to be regarded as a relict swamp type whose vegetation represents vestigial remnants of a more northern type of flora which has been much more widely represented in this region within very recent geological time. It does not, however, seem advisable to assume that "the habitat dates back

* Here again the contemporaneous condition of the vegetation in northern Cape Breton Island affords an instructive analogy. Four of the most characteristic Connecticut swamp trees, viz., *Acer rubrum*, *Ulmus americana*, *Fraxinus nigra*, and *Betula lutea*, are likewise found there; but they are restricted to the uplands, almost never occurring in swamps. This is the condition which the writer presumes obtained in this state at the period in question.

to Pleistocene times,"* since from a physiographic standpoint it is doubtful if such an assumption is tenable.† In the opinion of the writer the bog habitats at present in existence may be of much more recent origin.

As has been mentioned elsewhere,‡ there is abundant evidence tending to show that this invasion of areas populated by northern bog plants is still going on. At several localities in the state are bogs in which black spruce and coast white cedar occur together, and in every instance the cedar seems unmistakably to be gaining the ascendancy. In Southington is a large, boggy swamp now overgrown with red maple and elm. Scattered about in parts of the swamp, however, are numerous specimens of black spruce, most of which are either dead or dying. Similar relations may be observed elsewhere, and it is of importance to note that wherever

* Transeau, E. N., *loc. cit.*, p. 37.

† One of the objections to this assumption is pointed out by Dr. C. A. Davis in a recent letter to the writer. "It is probably a conservative estimate . . . that the end of the Wisconsin glaciation in Connecticut occurred from 20,000 to 50,000 years ago. If even the lower estimate be taken, and we assume that any given bog started 20,000 years ago and grew at its present rate of development, say with the peat accumulating at the rate of one foot per century, it is obvious that in the two hundred centuries which have elapsed, the physiography of the habitat would be entirely changed, and that we would have no bogs at the present day." He cites the occurrence of a "cassandra bog at sea level on the coast of North Carolina. It is certainly five hundred miles south of the greatest known extent of the Wisconsin drift, and on an area which apparently was below sea level not a very long time ago." He further states as his opinion that "such facts make the theory of glacial influence, except so far as the ice sheet provided favorable topographic conditions for the growth of bogs, practically untenable." Nor does he "believe that we need this explanation, since our present climatic conditions closely approximate those of glacial times. We are probably near enough to the borders of the zone of boreal influences so that our flora is a mixed one, not from influences exerted in the past, but from those of the present day; and the fact that we find on all our peat deposits overlapping northern and southern floras, as is shown by every list of plants made from associations growing in bogs, in a way supports this contention. It seems to me that our chief assumption should be that the northern plants are present in bogs because in such places they find conditions favorable for their development and growth, and that they are displaced only when these conditions become unfavorable. The fact that most of the northern plants of bogs have fruits that are attractive to birds, or else very small light seeds—and we know that migrating birds make bogs a part of their southern migration route—would seem to help account for the occurrence of northern plants which, after they are established, spread rapidly." It will be seen that Dr. Davis is not wholly in accord with the views of the writer, much less so with those of Transeau.

‡ Torreya 13: 99. 1913.

the spruce is cut off it becomes largely, if not entirely, replaced by red maple. While, therefore, the writer's conception as to the origin of spruce bogs is based entirely on circumstantial evidence, the explanation set forth seems to account in a satisfactory manner for the observed facts.

Occurrence of Spruce Bogs in Connecticut.—So far as the writer has been able to ascertain from his own field work and from inquiry among local botanists, fewer than thirty spruce bogs are known to exist within the state. These are distributed as follows: Salisbury*, Norfolk (3)*, Kent (2), Litchfield*, Suffield (6)*, South Windsor (2), Willington*, East Thompson (2), New Fairfield*, Monroe*, Middlebury (2), Southington (2)*. Bogs containing an admixture of spruce and coast white cedar occur at Bethany*, Plainfield (2)*, Willington and Windham; while spruce grows in a red maple swamp at Southington*.

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SHEFFIELD SCIENTIFIC SCHOOL OF YALE UNIVERSITY

* Bogs so marked have been visited by the writer.

Polypodium marginellum and its immediate allies*

William R. Maxon

Among the numerous groups of species comprising the section *Eupolypodium* of the genus *Polypodium*, as represented in tropical America, there are few if any which have a general structure so simple and unusual as that exhibited by *Polypodium marginellum* and several closely related species. This group, of which there are at least five American members, is represented also in Africa, as discussed below. The several species, which apparently are all epiphytes of moist mountain forests, are closely similar in general form, the fronds being of a narrowly linear type, simple, 5–25 cm. long, pinnately veined, and having the entire or slightly undulate margin bordered with a capillary or flattish, lustrous, dark brown or ebeneous band of sclerotic tissue, which from its firm structure is not readily perishable and may even persist long after the green tissue of the frond has disintegrated and disappeared. This sclerotic band has, so far as can be observed, no connection whatever with the fibrovascular conducting system; that is, the midvein and veins, the latter terminating at a point relatively remote from the margin. It seems rather to function primarily as a mechanical device to give strength and rigidity to the fronds, though not improbably it meets also some physiological need that is not at once apparent.

The marginal sclerotic structure just described is apparently unique in *Eupolypodium*. What appears at first to be a similar case is seen in *Polypodium gramineum* Swartz, a West Indian plant with small, very narrow, simple, entire, darkish-margined fronds; but in this species the dusky border is actually composed of conducting tissue, consisting of a marginal vein which connects the excurrent ends of the once or twice-branched lateral veins. Just outside of the marginal vein may be observed a delicate line of greenish tissue (as is not the case in *P. marginellum* and its allies),

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which suggests that reduction in the leaf expanse has taken place inward to the boundary of the longitudinal series of simple areoles constituting the venation of the leaf. The venation of *P. gramineum* is not precisely matched in any other species of *Eupolypodium*, but its peculiar character is certainly not of sufficient weight to warrant giving more than minor rank, in classification, to this species which is the type of Swartz's genus *Grammitis*. In any event the actual structure is fundamentally different from that of *P. marginellum* and its immediate allies, as may be noted readily upon an examination of specimens, and clearly places *P. gramineum* outside of this group.

Polypodium marginellum Swartz, 1788, was the first species of its own group to be described. It has since been very generally misunderstood and has been regarded mistakenly in so broad a sense as to include most of its allies, at one time or another, largely because of insufficient material for study. Without tracing in detail the varying treatment of the several forms, which is of historical interest merely, it seems worth while to offer the following key and brief synopsis, by means of which it is believed the several species may be distinguished.

KEY TO THE SPECIES

Fertile and sterile veins both mostly once forked, the branches produced.

Lamina linear, long-attenuate downward from the middle or lower, persistently hirtellous upon both surfaces and ciliate with short, stiffish, mostly simple, brown hairs; stipe usually short; rhizome scales entire or nearly so.. 1. *P. marginellum.*

Lamina oblanceolate, attenuate downward to the slender greatly elongate stipe, deciduously ciliate with lax, delicate, gland-tipped, mostly simple hairs, a few similar hairs evident at first along the midvein beneath; rhizome scales evenly sinuate-dentate..... 2. *P. leptopodon.*

Sterile veins simple; fertile veins nearly simple, the elliptical receptacle partially overlying the vein or wholly divergent as a short, oblique, translucent distal spur.

Rhizome scales rather lax, ligulate, yellowish brown in mass; sori nearly medial upon the veins, mostly apart from the midvein..... 3. *P. limbatum.*

Rhizome scales rigid, subulate to acicular, reddish brown in mass; sori distinctly inframedial, usually thrust against the midvein or even concealing it.

Veins arising at an angle of 30 to 35°.

Lamina rigidly coriaceous, semiopaque, with a relatively heavy sclerotic marginal band..... 4. *P. nigrolimbatum.*

Lamina membrano-chartaceous, translucent; marginal sclerotic line very slender, delicate.....	5. *P. Hessii.*
Veins arising at an angle of about 20°, closer; plants more delicate than the preceding, with smaller, usually much narrower fronds.....	6. *P. ebeninum.*

1. POLYPODIUM MARGINELLUM Swartz, Prodr. Veg. Ind. Occ. 130. 1788

Grammitis marginella Swartz, Jour. Bot. Schrad. **1800**[2]: 17. 1801.
Mecosorus marginellus Klotzsch, Linnaea **20**: 405. 1847, in part.

TYPE LOCALITY: High mountains of Jamaica.

DISTRIBUTION: Blue Mountains, Jamaica, at 1,500 to 2,100 meters elevation.

ILLUSTRATION: Schkuhr, Krypt. Gew. 1: *pl. 7* (as *Grammitis marginella*).

As indicated in the key, *Polypodium marginellum* is very strongly characterized by its long-forked veins and persistently hirtellous surfaces, characters which distinguish it at once from those allied species which have commonly been referred to it as the same or as only subspecifically different. Jenman, who clearly indicated its distinctness,* had seen no continental specimens; nor has the writer, though there are several mainland records, including a recent one for Costa Rica.† These probably relate to *P. nigrolimbatum* Jenman. Thus, Wright, in writing of the ferns of Mount Roraima,‡ has listed certain specimens as *P. marginellum*, with the remark: "Swartz says this species has "venis bifidis"; subsequent authors describe the veins as simple, which is the case with all the specimens at Kew." It is remarkable that true *P. marginellum* should be lacking at Kew, for it is decidedly the commoner of the two Jamaican species. Of the four Roraima specimens cited by Wright only one (*McConnell & Quelch* 568) has been seen; this is *P. nigrolimbatum.*

The following specimens of *P. marginellum*, all from the Blue Mountains, Jamaica, are in the National Herbarium: *Hart* 72; *Maxon* 1335, 1476, 2676, 2709; *Underwood* 1518, 2494, 3190, 3200.

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* Bull. Bot. Dept. Jamaica II. 4: 69. 1897.
† Christ, Bull. Herb. Boiss. II. 4: 1101. 1904.
‡ Trans. Linn. Soc. II. Bot. 6: 83. 1901.

2. POLYPODIUM LEPTOPODON Wright, Trans. Linn. Soc. II. Bot. 6: 83. 1901

TYPE LOCALITY: Summit of Mt. Roraima, British Guiana, altitude about 2,620 meters.

DISTRIBUTION: Known only from the original collection (*McConnell & Quelch* 569).

Polypodium leptopodon is a well-marked species, related to true *P. marginellum* Swartz, with which it is contrasted in the preceding key. In general form it is simulated somewhat by an occasional specimen of *P. marginellum* in which the fronds are very numerous and through crowding have developed uncommonly long and slender stipes; but it differs constantly in characters of pubescence and rhizome scales. The sori, as usually also in *P. marginellum*, are borne on the base of the elongate branch, the two veinlets being subequal and terminating well short of the margin.

Besides a specimen of the type collection sent from Kew the writer has examined several plants of the same number in the Underwood Herbarium of the New York Botanical Garden. No other specimens have been seen, the species apparently being very rare.

3. **Polypodium limbatum** (Fée) Maxon

Grammitis limbata Fée, Gen. Fil. 233. 1852; Mém. Foug. 6: 6. 1853.

TYPE LOCALITY: Guadeloupe.

DISTRIBUTION: Guadeloupe, at 750 to 1,300 meters elevation; also St. Vincent, at 600 meters.

ILLUSTRATION: Fée, Mém. Foug. 6: *pl. 5, f. 1.*

This species, described originally upon specimens collected by Perrotet, has been very imperfectly known and understood, probably because of its rarity. Excellent Guadeloupe specimens of the Duss collection in the Underwood Herbarium show it to be amply distinct, however. Fée's illustration is excellent in all particulars save one; namely, that the sori, while nearly medial upon the veins, are not borne midway between the midvein and margin, owing to the basal curvature of the veins. The relatively pale scales, ligulate form of the exstipitate fronds, broad marginal band, and position of the sori at once distinguish it from its nearest ally, *P. Hessii*.

4. POLYPODIUM NIGROLIMBATUM Jenman, Bull. Bot. Dept. Jamaica II. 4: 69. 1897

Grammitis fluminensis Fée, Crypt. Vasc. Brés. 85. 1869. Not *Polypodium fluminense* Vell. Fl. Flum. 11: *pl. 66.* 1827; Mus. Nac. Rio Janeiro 5: 447. 1881.

TYPE LOCALITY: Jamaica.

DISTRIBUTION: Blue Mountains, Jamaica, at 1,500 to 1,800 meters elevation; also in Brazil, British Guiana, and Bolivia, ascending to 2,600 meters.

ILLUSTRATION: Fée, op. cit. *pl. 19, f. 3* (as *Grammitis fluminensis*).

Jenman in writing of the ferns of Jamaica well distinguished this species from *P. marginellum*, its only near relative in Jamaica, but erroneously cited *Grammitis limbata* Fée as a synonym. The fronds are numerous, fasciculate, acute, and rigidly coriaceous, and narrower and more stiffly erect than in *P. marginellum*, which, though widely different in venation and minute characters, it somewhat resembles otherwise. The continental specimens are often larger than the Jamaican, but seem no different in other respects. Fée's species, *Grammitis fluminensis*, is apparently the same, judging by a fragment of the type collection in the Underwood Herbarium, but the specimen figured by him is certainly atypical in having obtuse apices.

The largest and most perfect Jamaican material studied is that collected by the writer from mossy tree trunks on the upper forested slopes of Monkey Hill (above New Haven Gap), altitude about 1,800 meters, June 22, 1904 (*Maxon* 2724, 2748).

5. **Polypodium Hessii** Maxon, sp. nov.

Plants epiphytic, 8–14 cm. high, the fronds few, ascending, subfasciculate. Rhizome decumbent or short-creeping, 1–1.5 cm. long, 2–3 mm. thick, sparingly radicose beneath, the small apical portion slightly exposed, inconspicuously paleaceous; scales dark reddish brown, rigidly acicular, subfalcate, subflexuous toward the tip, 2–4 mm. long, 0.2–0.3 mm. broad, the cell walls richly colored; stipe slender, about 1 cm. long, brownish, alate, passing gradually into the lamina, deciduously pubescent with minute branched glandular hairs; lamina 7–13 cm. long, 5–9 mm. broad, linear, narrowly attenuate in the basal third, a little more

abruptly attenuate in the apical part (the extreme apex subcaudate), the margins delicately repand, appearing undulate in drying, bordered by a delicate filiform line of lustrous blackish-brown sclerotic tissue, this bearing a few minute caducous branched glandular hairs, similar hairs extending sparingly to the leaf tissue; veins free, arising at an angle of about 35°, slender, concealed, but their course easily evident, the sterile ones simple; sori oval, extending from below the apex to the middle of the lamina, seated partially or sometimes wholly upon a very short divergent translucent distal spur of the vein, far below its middle, thus borne close to the concealed but sharply elevated slender costa, separate or at maturity subconfluent. Leaf tissue firmly membrano-chartaceous, dark green, paler beneath, the veins easily evident without transmitted light.

Type in the U. S. National Herbarium, no. 694419, collected from mossy trunks of forest trees, Sierra de Naguabo, eastern Porto Rico, March 8, 1914, by Mr. W. E. Hess (no. 312). Mr. J. A. Shafer's no. 2328, collected at the same time and place, is identical. Other specimens studied, all from Porto Rico, are as follows: *Hioram* 334; *Blauner* 272; *Sintenis* 1791; *Shafer* 3320, 3516, 3660.

Polypodium Hessii is closely related to *P. limbatum* of the Lesser Antilles, but differs sufficiently in its more rigid and darker rhizome scales, in its nearly basal sori, and in its distinctly stipitate (rather than nearly or quite exstipitate), narrower, attenuate fronds. The marginal band of sclerotic tissue is, moreover, very delicate and threadlike, as opposed to the glistening, broadish, almost flat sclerotic band of *P. limbatum*. *P. Hessii* is not likely to be mistaken for the widespread *P. nigrolimbatum*, with which it is contrasted in the preceding key.

6. **Polypodium ebeninum** Maxon, sp. nov.

Plants apparently epiphytic; fronds numerous, 5–10 cm. long, ascending, imbricate-fasciculate in a small crown. Rhizome erect or ascending, 7–10 mm. long, 1–1.5 mm. in diameter, paleaceous, the apical portion partially concealed; scales acicular, 2–2.3 mm. long, 0.17–0.25 mm. broad, subflexuous toward the slender gland-tipped apex, rich castaneous from a yellowish brown base; stipe proper nearly wanting, alate, passing gradually into the narrow lamina from a brownish base; lamina 5–9 cm. long, 2–4 mm. broad, straight or slightly arcuate, narrowly linear, acutish or obtuse, broadest in the apical third, thence very gradually long-attenuate to the base, entire, slightly repand, the margin consisting

of a slender band of rigid lustrous ebeneous sclerotic tissue, glabrate; veins numerous, free, very oblique, arising at an angle of about 20°, the sterile ones simple, the fertile ones essentially so, the sori (usually confined to the apical half of the lamina) distinctly inframedial in attachment, seated upon an elliptical translucent receptacle lying upon the distal side of the vein and scarcely divergent from it, relatively large, crowded against the costa, the two lines of sori more or less confluent at maturity. Leaf tissue glabrous, rigidly herbaceous, translucent, dark green above, paler beneath; costa slender, dark brown, elevated beneath; veins readily seen beneath without transmitted light.

Type in the U. S. National Herbarium, no. 370659, collected upon the island of St. Helena, 1885, by W. H. King.

Reported commonly from St. Helena, as *P. marginellum*, but in the National Herbarium represented only by the specimens of Mr. King. It is the smallest member of the group and readily recognizable as distinct from its American relatives in both gross and minute characters. This or a very closely related form is mentioned from Guinea by Link,* as *P. marginellum*. There is also a single Canary Island specimen, collected long ago by L. von Buch, which may possibly be the same. This was first referred to the West Indian *P. gramineum* (*Grammitis linearis* Swartz), but was afterward described as a new species, *Grammitis quaerenda* Bolle.† Still later it was discussed by Kuhn,‡ who mentions the "characteristic deep black margin" and refers it to *P. marginellum*, adding that it is identical with specimens collected on St. Helena by d'Urville and apparently misidentified by Mettenius as *P. gramineum*. Kuhn's unsupported statement as to the identity of the Canary Island and St. Helena plants does not, however, seem at all conclusive, in view of the several very obvious errors of fact which occur elsewhere in his paper and considering also the circumstance that under the name *P. marginellum*, with a single variety, he lists a total of only six specimens (apparently all that were known to him) which certainly pertain to no less than three species. It seems proper to describe the St. Helena plant as new, for it is not at all improbable that the Canary Island form, if eventually found in sufficient quantity for study, will prove to be a distinct species.

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* Fil. Afric. 149. 1868.

† Zeitschr. Allgem. Erdk. II. 14: 324. 1863.

‡ Oesterr. Bot. Zeitschr. 16: 70. 1866.

Medullary spots and their cause

J. G. Grossenbacher

(with plates 10 and 11)

Introduction

It is practically an established fact now that the common types of medullary spots or "pith flecks" so frequently found in the wood of trees and shrubs, are due to the mining of insect larvae in the cambium. The reliability of such marks as aids in determining the wood of forest trees therefore depends upon the relative distribution of the different species of cambium miners and the plants they infest.

The injurious effect of the mining on the health of the host usually depends upon the relation of the mined or eaten area of cambium to the area of the portion that is uninjured. In the case of large trees the effect on the host is usually slight while on a small tree or shrub a very heavy infestation may result in marked stunting of the plant's growth. Some woods may become worthless for finishing purposes owing to the presence of numerous occluded mines. Perhaps the chief pathological interest in this matter lies in following the response of the affected regions of the bark which results in proliferations to occlude the channels left by the foraging miners, and also in the development of new cambium over the outside of the mines.

This article is an addition to and a continuation of a short paper* written a few years ago, in that more of the details of the host's response as well as the complete life history of the miner discussed in the latter part of the earlier paper (pp. 63–65) are given. It is based on notes and specimens accumulated during the years 1910–12.

Some additional and more recent literature

All of the important earlier literature on the botanical side of the subject of medullary spots was reviewed in some detail in the

* Medullary spots: a contribution to the life history of some cambium miners. N. Y. Agr. Exp. Sta. Tech. Bull. 15: 49–65. 1910.

above cited paper before giving the life history of the *Ribes* miner (*Opostega nonstrigella*). A little later Record* published a very similar review of the same literature and added some observations on the occurrence of medullary spots in other hosts. Another review of the early literature was given in a later paper by Brown† in which he also records additional hosts and gives some details regarding the mines and miners. Five very excellent plates give interesting information about the mines. However, in his discussion of the occlusion of the channels made by the insects, occurs an error that should not be left unmentioned: "The larva destroys only those cells in its immediate path through the inner bark. . . . As the cambium layer moves outward radially, the passage left by the larva increases in diameter. For this reason, when growth is very rapid, the pith-fleck spots are larger than when it is slow." The error in these statements may be readily shown by quoting from a few lines below out of the same paper: "The healing process proceeds mainly from the bast pith-ray cells in the bark." This shows that Brown's observations were correct and that the channels once made are not moved outward radially by further growth of cells on the wood-side of the wound. In other words, it is unlikely that subsequent growth could widen a channel made by a cambium miner and it is very apparent that the mines are made narrower by the enlargement of the normal cells on both sides. Plate 4 of his paper shows how the channels are filled mainly by proliferations from the rays on the bark side.

The first to determine the most important stages in the life history of a cambium miner was Nielsen.‡ He studied the larva in all its stages, the pupa as well as the imago, though the egg was not found. The miner proved to be the larva of a fly, *Agromyza carbonaria*. He found that the larvae fed in the cambium until autumn and then entered the ground, where they passed the winter as pupae. The adult flies emerge in May.

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* Record, S. J. Pith flecks or medullary spots in wood. For. Quar. **9**: 244–251. 1911.

† Brown, H. P. Pith-ray flecks in wood. Forest Ser. U. S. Dept. Agr. Cir. **215**: 5–15. *pl. 1–5*. 1913.

‡ Nielsen, J. C. Über die Entwicklung von *Agromyza carbonaria* Zett., der Urheber der "Markflecken." Zool. Anzeiger **29**: 221–222. 1905; Zoologische Studien über die Markflecke. Zool. Jahrb. **23**: 725–737. 1906.

At first the larva has but one hook and well-developed girdles of plates which increase in number per segment from the first to the last: the first segment having one, and the last or twelfth, from seven to nine. This is also characteristic of the *Prunus* miner as given in my former paper. The second hook eventually appears on the left of the first. It is very small and lies in the curve of the large one as is characteristic of an *Agromyza* larva. The length of the larva increases from about three millimeters to twenty millimeters before emerging from the bark to pupate in the ground. A girdle of small spines is developed on the second segment. They project caudad. Before the end of larval life the number of plate girdles is much reduced; the skin becomes thicker and wrinkles crosswise. The pupa is three to four millimeters long, barrel-shaped, and has the spiracles at the ends on the dorsal side.

Some of Nielsen's figures of the causal insect were later reproduced by Tubeuf* in an article on medullary spots. He made the interesting observation, also frequently noted by the writer, that the miners are present only in such trees of a species which have active cambium throughout most of the growing season. In the autumn they were found most numerous in trees growing in wet places. He secured only the larval stages of the miners.

Greene† recently gave an account of the pupation of a single larva of the river birch miner discussed by Brown and described the adult that emerged from it. The fly was thought to be *Agromyza pruinosa*, and the opinion is expressed that possibly it is the only species in America producing medullary spots. The latter, of course, is a premature and very unlikely assumption even as regards the dipterous insects that mine in the cambium of woody plants; besides it has long since been shown to be incorrect as regards cambium miners in general. At least one other cambium miner is a lepidopterous insect (*Opostega nonstrigella*). Owing to the fact that our knowledge of the subject is so very fragmentary and incomplete it is evident that we are not in position to generalize as yet. In fact if Greene's statement on page 474 of the above

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* Tubeuf, K. von. Über die Zellgänge der Birke und anderer Laubhölzer. Naturwiss. Zeit. Forst- und Landwirt. **6**: 235–241. 1908.

† Greene, C. T. The cambium miner in river birch. Jour. Agr. Research **1**: 471–474. 1914.

paper, to the effect that "*Agromyza pruinosa* remains in the pupal stage in the ground during winter" applies to the fly which he and Brown studied it certainly differs from the one discussed in this paper. The *Prunus* miner, as noted above, was found to hibernate in the cambium of the host during the winters of 1910–11 and 1911–12 in the larval stage and to pupate early the following summers.

LIFE HISTORY OF THE PRUNUS MINER

On pages 63–65 of my paper on medullary spots cited above are described the early stages of a cambium miner that feeds in *Prunus* and *Crataegus* but does not attack *Salix*. The observations upon which that discussion was based extended from August 15 to November 15, 1910; or to the time when the cambium had dormancy forced upon it by the early cold weather of western New York. The larvae continued mining until nearly mid-November but were mostly still under six millimeters in length when they ceased feeding.

In 1911 the first careful examination and the first large collection of miners was made on May 21. They had apparently been active for some time. The mines were most numerous in the thicker parts of the infested shrubs. The channels were larger than the ones made by the same larvae in the 1910 growth, as was readily seen by tracing them back to the previous year's growth. The larvae still fed with their lateral sides toward the wood and bark, but the end turns in their mines were both clockwise and counter-clockwise. In the stem near the ground the return trips were often only a decimeter or two in length resulting in a zigzag course, but some of them still were making trips 1.6 meters in length. About a fourth of the larvae had left their hosts by boring their way out through the bark. The holes were still open and could be readily seen once they had been found. The larvae usually came out through the bark a centimeter or more after making a lower turn. Some exit holes were found as high as a meter above but most of them were within two to four decimeters of the ground; others entered the cambium of the crown and roots before mining their way out. In many instances mines had been made downward to about the surface of the ground and then turned distad or upward a decimeter or more before making an exit. Several larvae were

found in their channels mining their way out above the ground during the early forenoon of May 21. Again late in the afternoon some were found with their heads protruding from exit holes. Many larvae were collected into fifty per cent. alcohol. They were from eleven to thirteen millimeters in length.

A large bundle of sprouts and seedling stems of *Prunus avium* and *P. domestica* 0.7–4 cm. in diameter was cut; and the ends of the sticks were stuck into vessels of soil. The soil in one vessel was made very wet and that in the other was about in condition for good tilth.

Several *P. domestica* and *P. avium* seedlings 1–4 cm. in diameter were found which had the cambium near the ground almost entirely destroyed by the numerous short-trip zigzag mines crossing and recrossing each other in that region.

On May 25 only about a sxith of the larvae were still in the host and by May 30 none were found under the bark; the mines were found occluded or closed. After a careful examination of the surface soil under clumps of *Prunus* sprouts and seedlings quite a number of small yellowish, somewhat fusiform and barrel-shaped pupae were found. Some were collected into alcohol. They were about 2.7 mm. in length and about 0.9 mm. in diameter (PLATE 10, FIG. 1). On examination of the surface soil in the vessels into which the *Prunus* stems had been inserted large numbers of the same pupae were found, indicating that they must be the pupae of the cambium mining larvae. In the vessel where the soil had been kept excessively wet a number of dead larvae were present, showing that excessive moisture prevents pupation in some cases. The stems were carefully removed and examined but no larvae could be found in them, while mines and exit holes were numerous. One of the vessels containing the pupae in its soil was placed in a cheese-cloth cage, and cheese-cloth was tied over the tops of the other vessels.

Pupae collected under *Prunus* shrubs on June 4 sank at once when dropped into alcohol while those collected on May 25 usually floated several minutes before sinking. The puparia seemed more tightly filled by the pupae on June 4 than before. On holding the vial containing pupae up to the light fully formed fly-like imagines could be distinctly seen. Twenty-five of the pupae collected under

Prunus shrubs were placed in soil in a breeding cage. On June 6 some more pupae were collected under both *Prunus* and *Crataegus* shrubs and placed in soil in the cheese-cloth cage. On June 14 they looked greyish black, apparently owing to the dark color of the insect inside.

On the morning of June 17 ten very small black flies were found flying about in the air space of a vessel over which cheese-cloth had been tied, and some were found walking about on the soil. Three were found dead and were placed in alcohol. They were about 2.5 mm. long. See FIGS. 2 and 3. Five flies (three females and two males) were placed into a glass tube containing the distal end of a *P. avium* shoot and the others into a quart fruit-jar which was inverted over a short green branch of *P. avium*.

Later in the day a search was made for the flies in the *Prunus* and *Crataegus* thickets but none could be found. However, quite a number of empty puparia were obtained from the soil beneath the shrubs. On June 21 all but one of the flies in the glass tube had died and it was placed in the fruit jar. The shoot in the tube was found to have groups of from one to four whitish eggs inserted under the periderm at the edge of a number of lenticels. Twenty eggs had been deposited under the periderm around the lenticels of this small twig by the three females caged with it.

A few flies emerged from the soil in the breeding cages each day until June 21 and were placed in vessels containing *Prunus* shoots; after that date all of the puparia were found empty. By June 25 most of the flies in the fruit-jar had died. The shoots were carefully examined and were also found to have eggs inserted under the periderm at many of the lenticels. Numerous larvae had already emerged from the eggs and were mining in the cortex while some had even mined as far as three centimeters in the cambium. This shows that oviposition and hatching of the eggs took less than a week. The eggs measured about 0.2×0.07 mm.

Seedlings and sprouts of *P. avium* and *P. domestica* in a thicket were found to have eggs inserted about numerous lenticels on June 21. In many cases the larvae had emerged from the eggs and were mining in through the cortex and cambium. But in no instance could more than one egg be found at a lenticel. It appears therefore that the deposition of eggs in the caged *Prunus* shoots

was so frequently found to be in groups because of the large number of flies present as compared to the few lenticels in which oviposition could occur. Both in nature and in the cages the deposition of the eggs seemed to have been accomplished by the insertion of the ovipositor through the lenticel; as may be inferred from FIG. 4. This is a photograph of a shoot from one of the breeding jars after removing the periderm from a portion of it.

The larvae always emerged from the end of the egg turned away from the lenticel and fed first in the cortex just under the periderm, mining parallel with the surface of the bark from half a millimeter to three millimeters; then straight in toward the cambium, where they continued their mines up or down depending upon how the eggs had been inserted. Most of the eggs were inserted so that their long axes coincided with that of the plant. In cases where the eggs had been inserted at an angle with the long axis the larvae always turned in the direction of the lesser angle with the stem, irrespective of whether it was up or down the plant. The direction of the first mine therefore depends upon oviposition and perhaps the direction of the long axes of the cambium cells encountered by the larva and is not uniformly up or down as suggested by Kienitz, Greene, and others. For example, in the case of those shown in the above cited figure there is a group of two eggs from which the larvae would have mined first toward the distal end of the shoot, while from the group of three they would have mined toward the base of the plant first. Some larvae were found which had mined as far as four decimeters in the cambium in one direction; others had mined only about a decimeter and then reversed the course and mined in the opposite direction, after having veered to one side from the old course. The emerging larvae were about 2–2.5 mm. long and not more than 0.2 mm. in diameter. They were comparatively numerous: four empty egg cases were found at lenticels of a piece of a *P. avium* twig which was only about six millimeters in diameter and three decimeters long. The larvae were collected into alcohol.

The egg stage of these cambium miners is very short, apparently less than three days; while the larval stage lasts at least eleven months. The pupal stage lasts perhaps about three weeks, and the flies apparently oviposit within two days after emerging from the puparia.

On July 16 the new generation of cambium miners was found to be rather few in number as compared with the large number of eggs and young that were present in late June. Possibly the excessive and very long drought in connection with the unprecedented hot weather in western New York during the latter part of June and the first part of July (1911) reduced cambial activity to such an extent as to make mining difficult and resulted in the death of many larvae.

COMPARISON OF THE PRUNUS AND OTHER DIPTEROUS CAMBIUM MINERS

When the life history of this *Prunus* miner is compared with that recorded by Nielsen for *Agromyza carbonaria* and with that given by Greene for *A. pruinosa*, as well as with the fragmentary history published by Kientz (discussed in my earlier paper), it becomes evident that though these miners are similar in many ways they must be different species. *A. carbonaria* and *A. pruinosa* pass the winter in the pupal stage in the ground while the *Prunus* miner goes through winter in the cambium of the host as a larva. The fact that the *Prunus* miner was never found in willows growing among infested *Prunus*, as recorded in my earlier paper, also goes to show that the insect so commonly present in *Salix* and *Betula* is not identical with the *Prunus* miner. In addition to the above noted and irreconcilable differences in the life histories and hosts of the miners there is a marked difference in the size of all the stages of the *Agromyza pruinosa* discussed by Greene and others and those of the one described in this paper. The most striking difference is to be found in the length of the larvae just before pupation: The measurements given by Greene and others for the fully grown larvae studied by them are 20–30 mm. while those of the fly under consideration here are only 11–13 mm. in length. The larvae of *A. carbonaria* also measure about 20 mm. in length; and besides, Nielsen calls especial attention to the reduction in the number of plate-girdles preceding pupation which does not hold of the miner of *Prunus*. The *Prunus* miner retains all the girdles at least to within a day of pupation. The adults of *A. carbonaria* and *A. pruinosa* as given by Nielsen and by Greene are also larger than these. The venation of the wings figured by

Nielsen for *A. carbonaria* and of *A. pruinosa* by Greene also differs from that of the wings of this species, as may be seen by comparing a, b, and c of FIG. 5. However, Brown's observations, published in the paper cited above, show beyond a doubt that the miner of the river birch also passes the winter as a larva in the cambium of the host, since on April 25 it was found feeding and measured 15 mm. in length. The *Prunus* miner appears to differ so materially from the other species in both its life history and morphology that I consider it best, at least provisionally, to name it **Agromyza Pruni** sp. nov.

THE OCCLUSION OF THE MINES AND THE NATURE OF THE WOUND-TISSUES PRODUCED

The configuration of the mines was described in some detail in my former paper but their occlusion and the reformation of the cambium over the streak-wound were only incidentally mentioned.

In sections showing mines near the cambium or within the unlignified zone one is able to see that a distinct new cambium develops over the channels by the division of the first to the third cell of the phloem outside the mine. FIGS. 6 and 7 give some idea of later but closely related stages. This new cambium is often found formed over the wounds before the regular cambial line is advanced that far, so that the cambium arches over the channels. FIG. 8 illustrates this point. The first noticeable change taking place in the cells surrounding a mine after the larva has passed is the rapid growth of the uninjured cells on the radial and bark sides of the channel. The phloem-ray cells usually enlarge more rapidly than the others and give rise to bladder-like proliferations which, after attaining considerable size, are cut off by septa from the cells giving rise to them (FIG. 9). The cells arising in this manner continue the growth in the same direction if space permits, and, if other proliferations do not crowd on the sides, their diameter becomes so great that septa soon form also parallel with the original direction of growth. See FIGS. 10 and 11. After the proliferating outgrowths from the rays encounter the opposite side of the mine the further enlargements are diverted in the directions of least resistance that are most nearly in line with their former direction of growth. In many instances of this type the cell back of the

terminal one undergoes lateral enlargement and proliferates into the available space, cutting off the outgrowth by a septum. An early stage of this process may be noted near the left of FIG. 9.

During the development of the substitute cambium over the streak-wound the growth of the phloem cells usually reduces the radial diameter of the mines from forty to sixty per cent. In the case shown in FIG. 12 this compression growth was so pronounced as to wholly prevent the usual form of occlusion. The phloem-ray cells appear to retard this general growth that brings about such a marked reduction of the channels, as may be seen from FIGS. 6 and 7 which show the status of things in an early stage. The broader rays have a more decided influence than the mono- or biseriate rays. As a matter of fact, the same characteristics may be noted in all the figures to a varying degree. The bark side of an occluded mine nearly always has a marked undulatory boundary line owing to the more active growth of the interray portions of the bounding phloem that occurs during the development of the substitute cambium over the wound. In some instances where channels were made through a region in which the rays are all monoseriate and at a time when radial growth is especially pronounced, they may be entirely closed by general growth from the bark and radial sides, thus leaving only the irregular lines of compressed waste and some irregularities in the arrangement of the cells to show the location of the medullary spot. That is, the growth of the interray portions dominates the healing process and thereby prevents proliferation from the rays, as shown in FIG. 12. The boundary line along the pith side of the occluded mine is usually fairly straight. This is especially noticeable in FIGS. 13 and 14. The tangential diameter of the occluded mine is from one to four or more times the diameter of the miner. This greater or tangential diameter of the original channel is also considerably reduced during the early stages of the healing process, as may be seen by the incurving of the bounding ray-cells, as well as by their bulging enlargements encroaching on the mined side. FIGS. 11, 15, and 16 show results under consideration. However, it is very unusual for the uninjured ray-cells on the sides to give rise to proliferations into the channels: the neighboring cells of the interrupted rays seem to respond more quickly, apparently owing to the

fact that longitudinal resistance or compression has been eliminated while in case of the others only the lateral pressure has been reduced. Neither diameter of a mine is increased by subsequent growth as suggested by Greene but all available evidence indicates that a considerable decrease occurs in both diameters during the occlusion of a cambium mine.

It appears that ordinarily the radial diameter of a channel is but little greater than that of the miner while the tangential diameter may be several times that of the larva. The principal reasons for this seem to be that the portion of the cambium most desired by the larvae for food is a sheath only a few cells in thickness and that they feed with the lateral sides toward the bark and wood. In that position the hooks with which the cell-walls are ripped open also lend themselves more readily to foraging a wide path in the plane of the cambium mantle than at right angles to it. The tangential widths of mines made by larvae of a certain size seem therefore to depend upon the relation of the movement and feeding impulses dominating them. When the cambial cells about a miner are in just the right stage to be most agreeable for food and the larva is hungry, and besides has no special desire to travel, it makes a very wide path; while if the cells encountered afford less suitable food or the insect is dominated by an impulse for movement rather than for feeding, the mine is made only large enough to permit its passage. That is, the mines have a greater tangential diameter at times chiefly because the larvae feed more voraciously and browse more widely at some times than at others. Compare the two medullary spots of FIG. 14: the lower resulted from a mine made in early summer, and the upper from one made in midsummer. Both appeared to have been made by the same larva, the lower one while the insect was younger and smaller.

The irregular mass of cells making up the tissue that occludes or fills up a channel left by a miner has the general appearance of pith. Like pith these occlusion masses come to serve as places for storing elaborated food. The chief difference between the appearance of sections from the two places lies in the greater variation in the size and shape of the medullary spot cells, as shown especially in FIG. 9. Sections of material collected in summer show that in general the cells occluding mines do not lignify

as soon as those of the normal tissue at an equal distance from the cambium; they also show that the cells making up medullary spots are not all of the same age nor produced under equal and like pressures: some of them lignify before others, some are angular while others are nearly circular in cross section. FIGS. 9, 13, and 14 show practically all of the types usually found.

The study of the development of such substitute tissues has much of indirect interest to plant pathology, and the wounds, when numerous, may sometimes not only prove very harmful to the host but incidentally afford entrance to parasitic organisms. In the case of *Prunus* no such connection with a fungous disease was established; a very striking example, however, was found in connection with the study of the *Ribes* cambium miner discussed in my earlier paper. In that case many of the shoots, vacated by a miner that it might pupate in the ground, were invaded by a fungus through the exit hole and killed back.

Description of plates 10 and 11

PLATE 10

FIG. 1. Pupae and puparium of the *Prunus* cambium miner (*Agromyza Pruni*). Upper right collected May 30; upper left collected June 4; lower right collected June 11; lower left collected after emergence of fly.

FIG. 2. Adult fly of *Prunus* miner (*Agromyza Pruni*) from breeding cage, 1911.

FIG. 3. Female with ovipositor extruded. From breeding cage, 1911.

FIG. 4. Twig of *Prunus avium* from breeding cage. The periderm removed to show location of two groups of eggs; the upper group had been inserted downward from lenticel above, and the lower one upward from lenticel below.

FIG. 5. Wings of various species of *Agromyza*. *a*, Wing of *A. carbonaria*, from Nielsen; *b*, Wing of *A. pruinosa*, from Greene; *c*, Photographed wing of *A. Pruni*.

FIG. 6. Medullary spot in *Prunus domestica*, near cambium; showing an early stage in the development of a new cambium from inner phloem cells.

FIG. 7. Medullary spot in *Prunus domestica* near cambium, after the production of a few xylem cells outside the spot.

FIG. 8. Medullary spot with new cambium just developed outside the wound; being in advance of the other cambium as shown at right of figure.

FIG. 9. Medullary spot in which the cells are not all mature, showing a marked variation in the size and shape of the cells.

FIG. 10. Medullary spot, made by a young larva and filled by proliferations from the rays and by the incurving of the radial rows on the sides as well as by the general growth on the bark side. (Upper.)

FIG. 11. Medullary spot, made by a young larva, filled by proliferation from ray on bark side and by bulging of ray from left side. The cells of the bulging ray are shown also to have undergone longitudinal division.

FIG. 12. Medullary spot shown only by the presence of irregular lines of compressed waste. This channel was occluded at this point by general growth and not by proliferations from rays as is usually the case.

FIG. 13. Medullary spot, showing that bark rays not only proliferate freely into mines but that they *thereby* prevent or retard the general compression growth, that is especially pronounced at the left where large rays are absent.

PLATE 11

FIG. 14. Two medullary spots, apparently made by the same miner, also showing well marked differences between boundary lines on the bark and pith sides of the occluded channel.

FIG. 15. Medullary spot showing incurving of bounding rays at right and left, as well as a bulging of the ray at right.

FIG. 16. Medullary spot showing incurving of rays and of other radial rows.

INDEX TO AMERICAN BOTANICAL LITERATURE
1903–1915

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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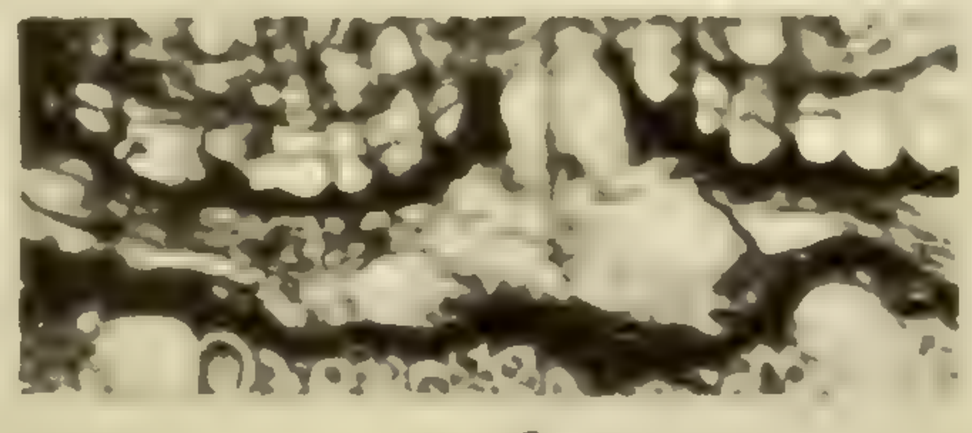

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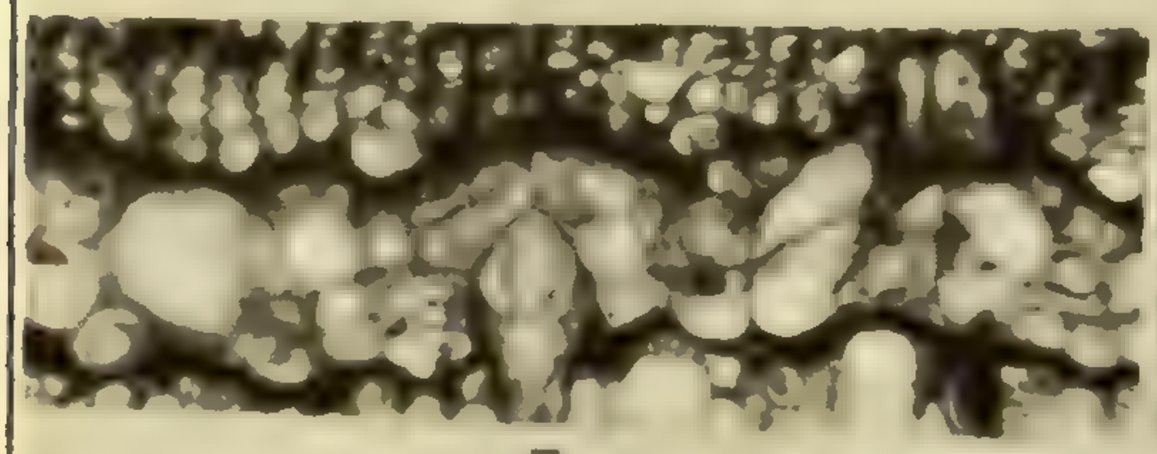

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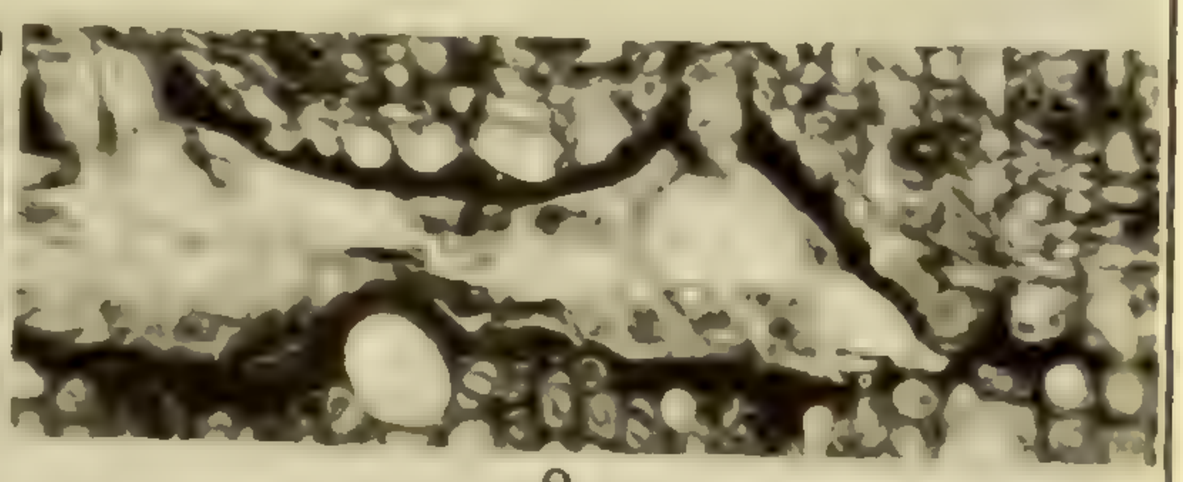

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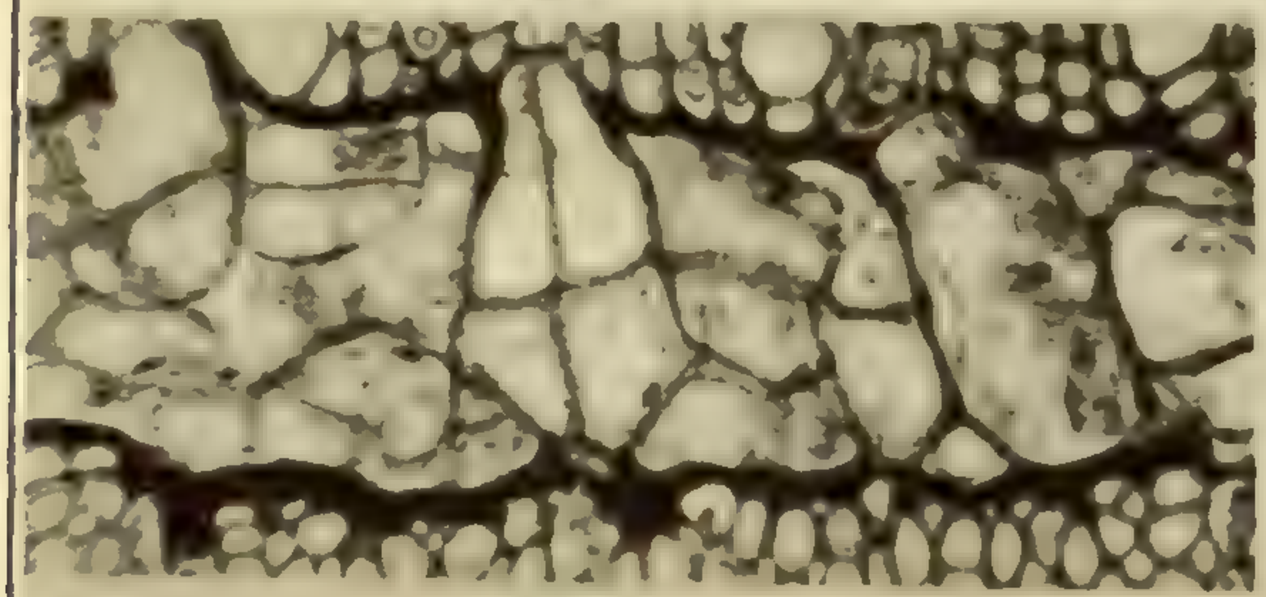

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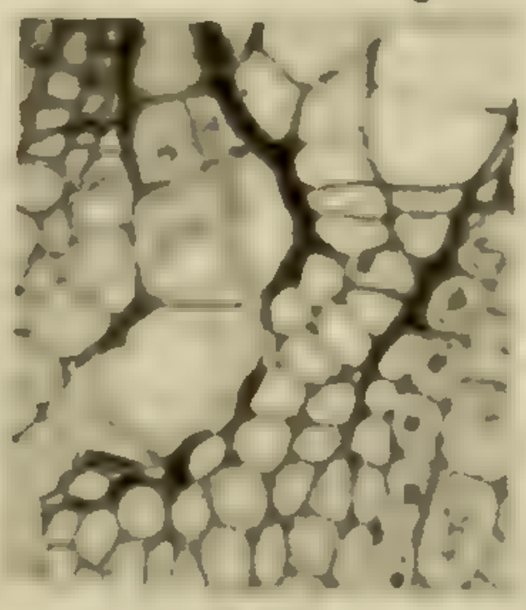

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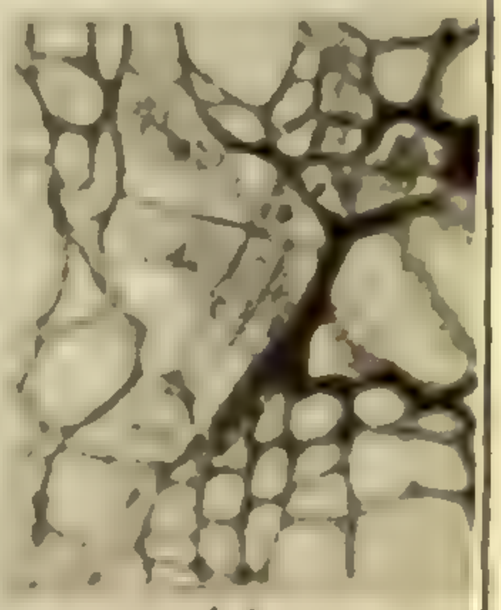

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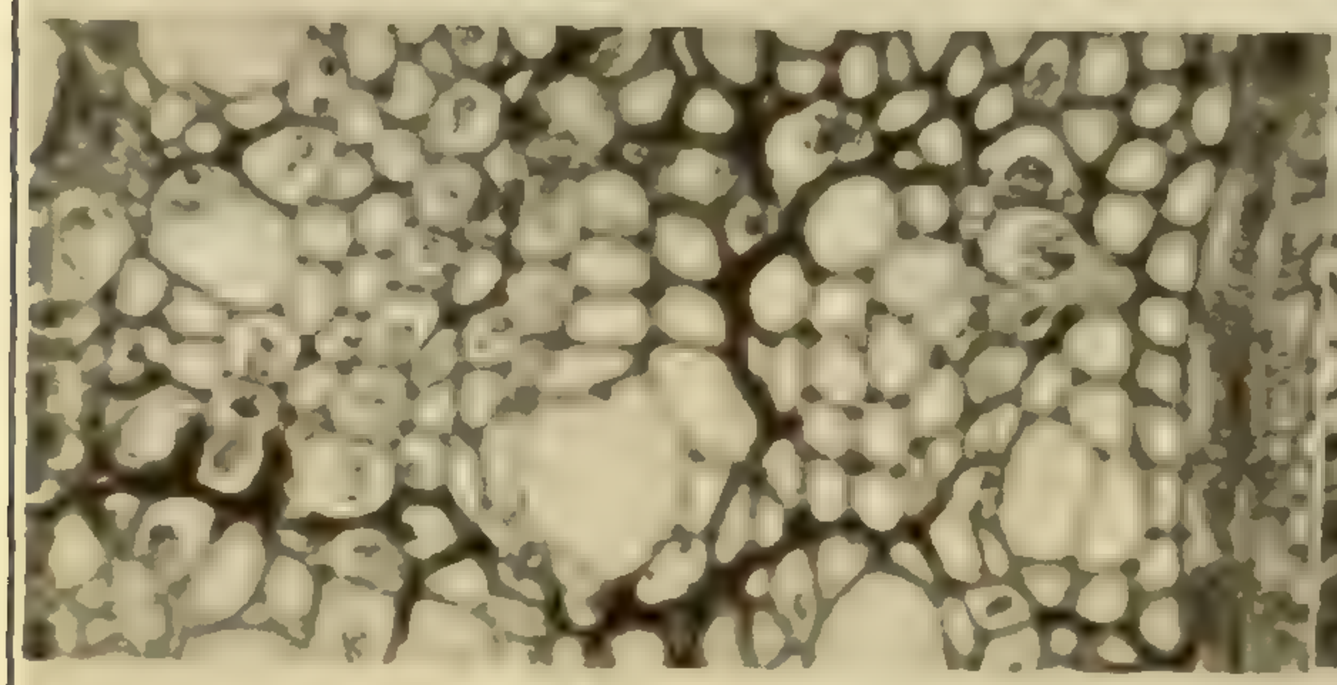

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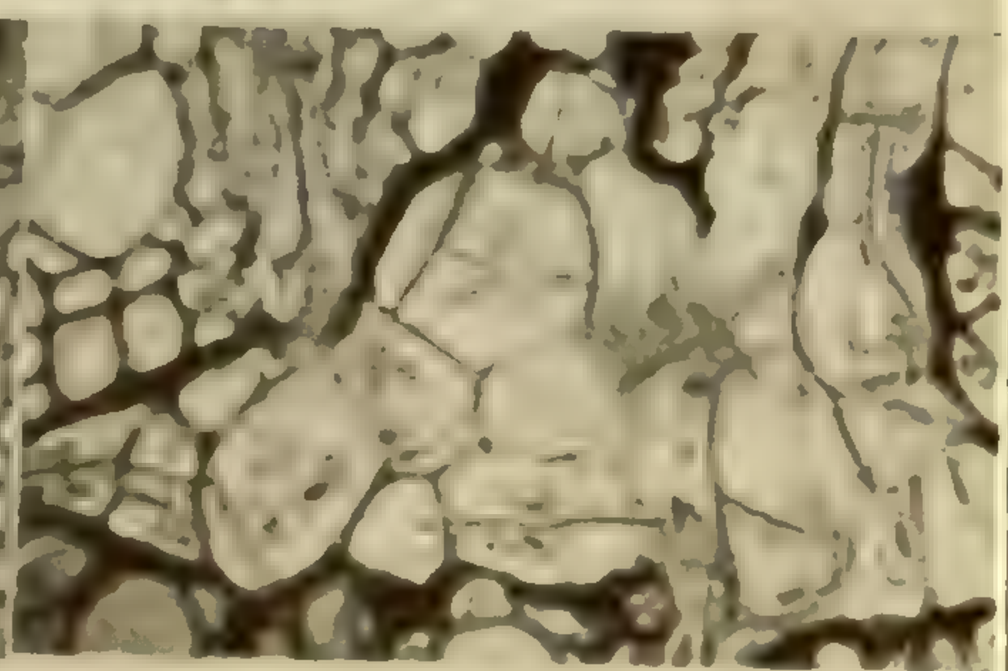

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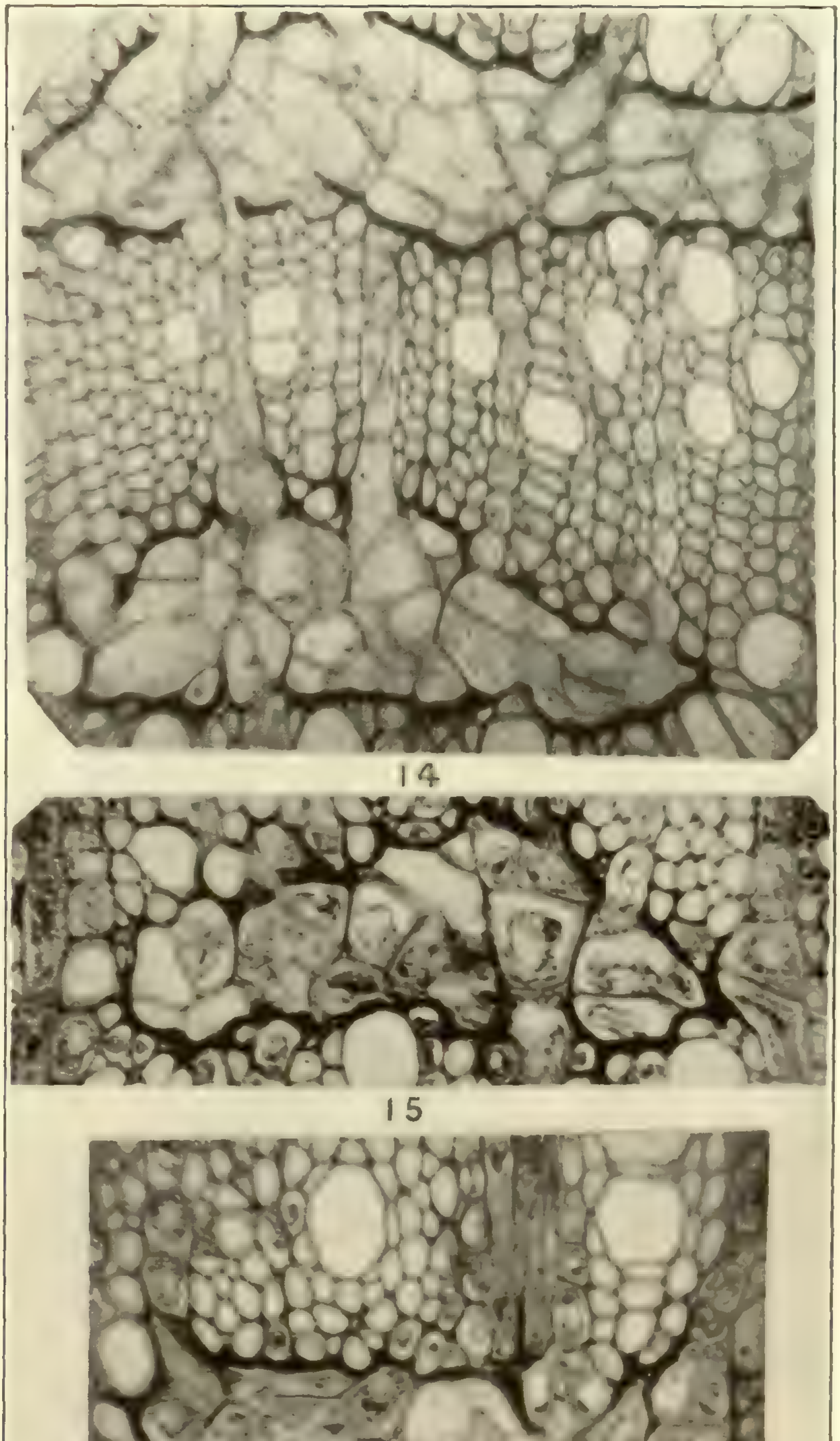

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GROSSENBACHER: MEDULLARY SPOTS

Vol. 42 No. 5

BULLETIN

OF THE

TORREY BOTANICAL CLUB

MAY, 1915

Notes on the Michigan species of Polygonatum*

OLIVER ATKINS FARWELL

(WITH PLATES 12–18)

Much difficulty has been experienced, during the past few years, in trying satisfactorily to place all our forms of *Polygonatum*, known as Solomon's Seal, within the prescribed limits of the two species accredited in our manuals to North America. There are a number of characters which seem to be common to all. The stem is finely many-striate, cylindrical and smooth when green but channelled more or less deeply when dry; the leaves of all are glaucous beneath and have minutely pubescent or papillose margins, the papillae of which range from 85 μ in *P. cuneatum* to 7 μ in *P. biflorum;* they are indefinitely nerved, the smallest having not less than fifty-five nerves, which can be definitely distinguished by the unaided eye; and they are never acute but end in a short, narrow or broad, very obtuse or rounded apex; the peduncles are compressed, channelled on one side, and arching; the pedicels, at least at the flowering season, are bracteate near their junction with the peduncle; the perianth-lobes are deltoid, dark green, and barbellate within; the filaments are partly adnate, partly free; the anthers are sagittate; the fruits are black with a bluish bloom, as in many species of *Vaccinium*, and if collected before maturity appear, in the dried specimens, to be indehiscent, but at full maturity they are dehiscent, rupturing with the slightest pressure; the bony, whitish or greenish white seeds are turgid, subreniform, and smooth. The forms can be definitely separated into

* Contributions to the Botany of Michigan, No. 11.

[The BULLETIN for April (42: 169-246. *pl. 10, 11*) was issued April 27, 1915.]

two groups based upon pubescence of foliage or lack of it, size of flowers, and form of filaments, the two groups corresponding to the two species usually recognized. But it is next to impossible to include under one species forms with yellow flowers and those with green; forms that are constantly seven or eight feet in height with those that never exceed one or two feet; forms that have elongated very narrow leaves with those that have very short and broad ones; forms with slender flexuous peduncles with those having coarse, rigidly wiry ones. Differences in size alone are not characters upon which to base new forms of plants but when correlated with other constant differences there is pretty good evidence for their recognition. An effort to place these forms led to an investigation of the publications of earlier botanists with some surprising and unexpected results.

It seems that neither Linnaeus, Miller, the elder Aiton, Murray, nor any of their contemporaries had recognized any American species of this group of plants nor even included American plants in the European species with which they dealt. Walter was the first to describe an American species, the *Convallaria biflora*, a glabrous plant with three-nerved leaves, which has since had a rather varied career. Bosc came next, describing *C. hirta*, a species with hispid peduncles and stems, otherwise glabrous. Michaux and Persoon referred the American species to the European *C. multiflora*. Wildenow followed with two new species, *C. pubescens* and *C. canaliculata*. Besides recognizing the above species under *Polygonatum*, now considered distinct from *Convallaria*, Pursh, suppressing Walter's specific name *biflora* and substituting for it his own name *angustifolium*, admitted *P. latifolium*, a European species, to a place in our flora. Poiret came next with *Convallaria parviflora*. The two Schultes described *C. commutata* and, in 1835, Dietrich added still another, *P. giganteum*. Thus in the first half century after the first American species had been described eight others were recognized by the earlier students of the American flora, seven being considered endemic and the other two identical with European species. It would thus seem that the botanists of a century ago had a more accurate conception of the genus in America than those of the present day. More than seventy years later Dr. Greene described

three other species, *P. virginicum*, *P. boreale*, and *P. cuneatum*, bringing the total number of species described for America up to twelve; but these, like most of the others, have not been generally accepted as valid. Dr. Hooker, in 1840, united the nine species then known and placed them all under *P. multiflorum* as var. *americanum*. Dr. Torrey followed the lead of Hooker and went even further by uniting them all under *P. multiflorum*, not even giving them varietal rank. In the first edition of the Manual, Asa Gray recognized *P. pubescens* Pursh and *P. canaliculatum* Pursh. In the second edition, the former becomes *P. biflorum* Ell., the latter, *P. giganteum* Dietr., and a third species, *P. latifolium* Desf., is admitted. In later editions *P. commutatum* supersedes *P. giganteum* and *P. latifolium* is eliminated.

As stated above, Walter was the first to describe an American species under *Convallaria*, and his description is as follows:

biflora 2. foliis semiamplexicaulibus trinervis laevibus, oblongis, acutis, altnernis; caule tereti laevi; pedunculis solitariis bifloris axillar, floribus flavescentibus.

Willdenow's descriptions, in part, of *C. pubescens* and of *C. canaliculata* are as follows:

Convallaria *pubescens*

Convallaria foliis alternis amplexicaulibus ovatis subtus pubescentibus, caule teretiusculo sulco exarto, pedunculis axillaribus subbifloris. . . .

Folia alterna ovata secunda basi leviter amplexicaulia integerrima nervosa, nervis 7 majoribus, supra saturate viridia glabra, subtus albicantia et ad nervos pilis albis obsita. Pedunculi uni- vel biflori secundi nutantes axillares. Corolla . . . albido-flavescens . . . .

Convallaria canaliculata foliis alternis amplexicaulibus oblongis margine pubescentibus, caule canaliculato, pedunculis bifloris axillaribus.

Differt a *Convallaria pubescenti:* foliis oblongis glabris margine tantum tenuissime pubescentibus, coralla magnitudine et facie Convallariae Polygonati. Hanc sub nomine *Convallariae multiflorae* in Flora boreali-Americana indicavit Michaux p. 202.

A very careful study of these descriptions never should have permitted any confusion as to the application of the names; if there are but two species in North America, then the proper names for them are *Polygonatum pubescens* (Willd.) Pursh, for the plant with pubescent leaves, and *P. biflorum* Walt., for the plant with glabrous leaves. Willdenow's plate illustrating the former (see PLATE 12) is excellent and is exactly matched by plants in Michigan. Both *C. biflora* and *C. canaliculata* are described as having oblong leaves and two-flowered peduncles; in the former the flowers are described as *yellow* and in the latter as of *the size and appearance of those of C. Polygonatum*, which are *green* and about seven lines in length; the leaves in the former are said to be three-nerved but Willdenow makes no mention of this feature; Kunth, however, in his description of Willdenow's plant says the leaves are ovate-oblong, about three inches long by sixteen or seventeen lines in width and striately many-nerved. The two cannot therefore be of the same species. Pursh described *P. angustifolium* with elliptical-lanceolate leaves; Elliott described *P. biflorum* Walt. likewise; in other respects these descriptions are essentially the same as that of Walter's *C. biflora*, each quoting the latter as a synonym. But an oblong leaf that is acute may be essentially the same as a leaf that is elliptical-lanceolate, and these three names and descriptions may, therefore, be considered as synonymous, Elliott restoring Walter's specific name, which had been suppressed by Pursh for one of his own coining.

It seems scarcely possible by the widest stretch of the imagination to include, under the above description of Walter, the pubescent-leaved plants with small greenish or greenish white flowers, yet that is not only what Gray and subsequent authors have done but they have finally come to make the latter form the principal element of the species to which Walter's name has been applied or rather misapplied. The confusion of these species was started by Dr. Hooker, continued by Dr. Torrey, and finally completed by Dr. Gray, when he ultimately and inexcusably transferred the name of Walter from the species described by that author to an entirely different one and not of very close relationship. And this interpretation has been blindly followed by subsequent authors for nearly half a century.

The Michigan species naturally fall into two groups—one containing low, slender plants having pubescent chartaceous foliage and small flowers with slender filaments; and the other containing robust plants having glabrous, membranaceous leaves and large flowers with large, stout filaments. Both are to be placed under Baker's section ALTERNIFOLIA. The first group may be known as the *Pubescentes* and the second, as the *Glabrata*. Under the *Pubescentes* three species have been described, *P. pubescens*, *P. cuneatum*, and *P. boreale*. In all these forms the filaments are papillate. Dr. Greene describes the peduncles of *P. boreale* as filiform and flexuous; this can scarcely be said of the specimens that have come under the author's observation, except as to the two or three uppermost, the others being too stout, compressed, and channelled to be called filiform; otherwise the specimens agree with Dr. Greene's descriptions. There is another form with the perianth pale green throughout or with the lobes just noticeably of a darker green than the tube.

In the *Glabrata* seven species have been described, *P. biflorum*, *P. hirtum*, *P. canaliculatum*, *P. parviflorum*, *P. commutatum* (all originally as species of *Convallaria*), *P. giganteum*, and *P. virginicum;* two others have been referred to the European *P. latifolium* and *P. multiflorum*, making nine in all. These species will fall into two series, one with yellowish white flowers and relatively narrow leaves and the other with greenish flowers and relatively broad leaves. Several forms can readily be recognized; also one form with ancipital stems has been found, i. e., in cross-section the outline is elliptical. *P. commutatum* and *P. giganteum* are but varying forms of *P. canaliculatum* and may better be considered as varieties of it. *P. virginicum* appears to be a broad-leaved form of *P. biflorum*. In Michigan another form is found which is analogous to *P. canaliculatum* but the flowers are yellowish. In this group it would be natural to look for *P. parviflorum* Dietr. (*Convallaria parviflora* Poir.). Such descriptions (not the original) of this species which the author has seen point unmistakably to some species of the *Glabrata* notwithstanding it is said to have flowers of the size of those of the *Pubescentes*. Probably the description was drawn from an immature dried plant and the flowers had not yet opened at the time of collection. Oftentimes the pressure exerted

in course of pressing will burst open the buds so that they appear to be matured flowers in the dried specimens. *P. hirtum*, a species with glabrous leaves, but with the upper part of the stem and the peduncles hispidly pubescent, would also be sought here but nothing answering to the description of either has been found in Michigan. No intermediate forms have come under the author's observation, i. e., none of the large-leaved, large-flowered forms has had pubescent leaves or small flowers nor none of the small-leaved, small-flowered forms has had glabrous leaves or large flowers. There appears to be no intergradation between the *Pubescentes* and the *Glabrata;* Walter's *P. biflorum* is typical of the latter and Pursh's *P. pubescens*, of the former.

Key to the species

Leaves pubescent on the veins underneath; flowers 6–10 mm. in length; filaments filiform, papillate; plants up to 4.5 dm. in height (*Pubescentes*).
- Flowers with a yellowish white tube.
  - Leaves ovate. — *P. pubescens.*
  - Leaves elliptical, cuneate. — *P. pubescens cuneatum.*
- Flowers green, leaves elliptical.
  - Leaves large, flowers dark green. — *P. boreale.*
  - Leaves small, flowers light green. — *P. boreale australe.*

Leaves glabrous; flowers 12–25 mm. in length, filaments more or less flattened; plants taller and stouter, 6–24 dm. in height (*Glabrata*).
- Flowers yellowish, free part of filament smooth, longer than the anthers.
  - Stems cylindrical.
    - Leaves cuneate-lanceolate. — *P. biflorum.*
    - Leaves ovate- to oblong-elliptical, flowers 12–14 mm. long. — *P. biflorum virginicum.*
    - Leaves ovate to lance-ovate, flowers 16–18 mm. long. — *P. biflorum ovatum.*
  - Stems ancipital. — *P. ellipticum.*
- Flowers green, filaments granular, or papillate, free part shorter than the anthers.
  - Peduncles two-flowered.
    - Leaves lance-ovate, flowers 14 mm. long. — *P. canaliculatum.*
  - Peduncles two- to eight-flowered.
    - Leaves ovate, flowers 12 mm. long. — *P. canaliculatum americanum.*
    - Leaves roundish ovate, flowers 14 mm. long. — *P. canaliculatum giganteum.*

POLYGONATUM PUBESCENS (Willd.) Pursh, Fl. Am. Sept. 234. 1814

Convallaria pubescens Willd. Hort. Berol. 45. *pl. 45*. 1816.
P. multiflorum β *americanum* (in part) Hook. Flor. Bor. Amer. 2: 176. 1840.
P. biflorum Ell. in A. Gray, Manual, Ed 2, 466, 1856, mostly and of subsequent authors. Not Walter in Elliott, Bot. S. C. & Ga. 1: 393. 1817.
Salomonia biflora Farwell, Rep. Com. Parks Detroit 11: 53. 1900.

Stems glabrous, up to 4.5 dm. high, 2–4 mm. in diameter, leafless part the longer; leaves nine to thirteen, ovate to lance-ovate, 17–33 mm. wide by 5–7.5 cm. long, amplexicaul, subsessile, or short-petioled, green above, pubescent on the nerves below; three to seven of the nerves more or less prominent; peduncles short, about 12 mm. long, one- or two-flowered; pedicels shorter than the peduncle; flowers 8–10 mm. long by 2–3 mm. wide, occasionally sessile, cylindrical, tube yellowish white or white in dry specimens; the free part of the filament filiform, papillate, and shorter than the anthers; mature fruit globular, 8–10 mm. in diameter; seeds three to nine, 4 mm. wide. [PLATES 12, 13, A.]

Generally in rather dry woods and copses of oak and maple. MICHIGAN: Keweenaw Peninsula, June, 1886, *Farwell 380;* Rochester, May, 1914, *Farwell 3624*. MASSACHUSETTS: Russell, May, 1873, *H. H. Rusby* (distributed as *P. biflorum*). NEW JERSEY: Franklin, August, 1879, *H. H. Rusby* (likewise distributed as *P. biflorum*).

Polygonatum pubescens cuneatum (Greene) comb. nov.

P. cuneatum Greene, Leaflets 1: 181. 1906.

Differs from the species only in having longer and relatively narrower leaves, cuneate at the base (18–35 mm. wide by 6–12 cm. long). [PLATE 13, B.]

MICHIGAN: near Marquette, *Greene ;* Detroit, May, 1895, *Farwell 380c;* Keweenaw Peninsula, October, 1914, *Farwell 3909*.

POLYGONATUM BOREALE Greene, Leaflets 1: 181. 1906

Leaves larger, elliptical, 33–45 mm. wide by 7.5–10 cm. long, generally sessile; flowers green, darker than the foliage, otherwise as in *P. pubescens*. [PLATE 14, A.]

Copses of oak and maple. MINNESOTA: Winona, *Greene*.

MICHIGAN: Keweenaw Peninsula, June, 1886, *Farwell 380a;* Ypsilanti, May, 1891, *Farwell 380b.*

Polygonatum boreale australe var. nov.

Leaves small (10–22 mm. wide by 2.5–5 cm. in length), elliptical or the lower inclined to ovate-elliptical; peduncles filiform, compressed only below the arch, one-flowered, flowers water-green (Ridgway's nomenclature), paler than the foliage. [PLATE 14, B.]

Sparsely wooded fields. MICHIGAN: Detroit, May, 1895, *Farwell 380d.*

POLYGONATUM BIFLORUM Walt. in Elliott, Bot. S. C. & Ga. 1: 393. 1817

Convallaria biflora Walt. Fl. Car. 122. 1788.
Polygonatum angustifolium Pursh, Fl. Am. Sept. 234. 1814.
Polygonatum multiflorum β americanum (in part) Hook. Flor Bor. Am. 2: 176. 1840.

Whole plant glabrous, with nine to thirteen, secund elliptical-lanceolate leaves (18 mm. wide by 10–12.5 cm. long), rounded or somewhat cuneately narrowed to a sessile base, and with three to five more or less prominent nerves; peduncles slender, about 12 mm. long, two-flowered; flowers yellow; stems about 4.5 dm. high and 2–3 mm. in diameter. [PLATE 15, A.]

Atlantic seaboard, not typically represented in Michigan.

Polygonatum biflorum virginicum (Greene) var. nov.

Polygonatum virginicum Greene, Leaflets 1: 181. 1906.
Salomonia commutata (in part) Farwell, Rep. Com. Parks Detroit 11: 53. 1900.

Differing from the typical form of the species in its larger, ovate-elliptical to oblong-elliptical leaves, which are 25–55 mm. wide by 10–18 cm. long, with fifteen to twenty-three of the nerves more or less prominent; in its larger stems, 6–8 mm. in diameter, 6–9 dm. high, with the naked lower portion equal to or longer than the upper leafy part; in its larger flowers which are funnel-shaped to linear-cylindric (4–6 mm. wide by 14–25 mm. long, even on the same plant), borne on longer (often three-flowered) peduncles (25–37 mm. in length), with subequal pedicels 6–10 mm. in length; fruit ovoid to globular, 12–16 mm. in diameter; seeds eight to ten. [PLATE 15, B.]

Moist grounds in woods or in shady places. VIRGINIA: *Greene*. MICHIGAN: Belle Isle, Detroit River, June, 1893, *Farwell 1150b;* Parkdale Farm, June, 1914, *Farwell 3676, 3677, 3682, 3683*. The most developed form of the species.

Polygonatum biflorum ovatum var. nov.

Salomonia commutata (in part) Farwell, Rep. Com. Parks Detroit 11: 53. 1900.

Differs from the above in having smaller ovate to elliptical leaves (18–37 mm. wide by 7.5–10 cm. long), with fewer conspicuous nerves (seven to nine) and short stems (4–6 mm. in diameter and 4.5–6 dm. in length), often with a foliaceous, sheathing bract 10–12 cm. below the first leaf, and generally smaller flowers (4–8 mm. wide by 14–18 mm. long). [PLATE 16, A.]

Open, rather dry woods and fields. MICHIGAN: Belle Isle, Detroit River, June, 1893, *Farwell 1150a;* near Rochester, June, 1914, *Farwell 3674, 3678, 3679*.

Polygonatum ellipticum sp. nov.

Whole plant glabrous; stems about 9 dm. in height, the naked lower portion (3.5 dm.) *shorter than the leafy part (5.2 dm.) and ancipital, the cross-section being elliptical in outline (6 × 10 mm.)*, whence the specific name; leaves about twenty, ovate-lanceolate (25–37 mm. wide by 7.5–10 cm. long), five to nine more or less prominent nerves, semi-amplexicaul, sessile; peduncles slender, up to 60 mm. in length with very unequal pedicels up to 25 mm. from four-flowered in the lower to one-flowered in the uppermost; flowers yellowish white, 16–20 mm. long by 4–5 mm. wide. [PLATE 16, B.]

Dry fields and pastures. MICHIGAN: Rochester, June, 1914, *Farwell 3673*.

POLYGONATUM CANALICULATUM (Muhl.) Pursh, Fl. Amer. Sept. 234. 1814; Kunth, Enumeration 5: 134. 1850

Convallaria canaliculata Muhl. in Willd. Hort. Berol. 45. 1816.

Polygonatum multiflorum β americanum (in part) Hook. Fl. Bor. Am, 2: 176. 1840.

Whole plant glabrous; stems cylindrical, 6–10 mm. in diameter, about 10 dm. high, equally divided between the naked lower portion and the upper leafy part; leaves about fourteen, ovate to elliptical, 30–55 mm. wide by 10–14 cm., with nine to thirty-one more or less conspicuous nerves, semi-amplexicaul, subsessile or

sessile; peduncles up to 30 mm. in length, with equal pedicels 12 mm. or less, two-flowered; flowers green, broadly tubular, 12–14 mm. long by 4–6 mm. wide. [PLATE 17, A.]

Moist elder thickets. MICHIGAN: Rochester, June, 1914, *Farwell 3677½*.

✓ **Polygonatum canaliculatum americanum** (Hook.) comb. nov.

Polygonatum latifolium Desf. in Pursh, Flor. Amer. Sept. 235. 1814.

Convallaria commutata J. A. & J. H. Scult. Syst. 7: 1671. 1830.

Polygonatum commutatum Dietr. in Otto & Dietr. Gartenz. **3**: 223. 1835.

Polygonatum multiflorum β americanum (in part) Hook. Fl. Bor. Amer. **2**: 176. 1840.

Polygonatum latifolium var. *commutatum* Baker, Jour. Linn. Soc. Bot. **14**: 555. 1875.

Polygonatum biflorum commutatum Morong, Mem. Torrey Club **5**: 115. 1894.

Stems 9–12 dm. in height, cylindrical, about 10 mm. in diameter, only the lower third naked; leaves eighteen to twenty-eight, ovate-lanceolate, 25–60 mm. wide by 7.5–14 cm., with nine to thirty-one more or less conspicuous nerves, peduncles often 5 cm. in length with subequal pedicels, 18 mm. or less, two- to eight-flowered (generally six- or seven-flowered on the lower peduncles); flowers 14 mm. long by 4 mm. wide. [PLATE 17, B.]

Low wet situations in open fields and thin woods. MICHIGAN: Ypsilanti, June, 1893, *Farwell 1150;* near Rochester, June, 1914, *Farwell 3675*. NEW JERSEY: Franklin, August, 1875, *H. H. Rusby* (distributed as *P. giganteum*). ONTARIO: Walkerville, June, 1891, *A. L. Johnson* (likewise distributed as *P. giganteum*).

✓ **Polygonatum canaliculatum giganteum** (Dietr.) comb. nov.

Convallaria multiflora L. in Michx. Fl. Bor. Amer. **1**: 202. 1803.

Polygonatum multiflorum Desf. in Pursh, Fl. Amer. Sept. 234. 1814.

Polygonatum giganteum Dietr. in Otto & Dietr. Gartenz. **3**: 222. 1835.

Polygonatum multiflorum β americanum (in part) Hook. Fl. Bor. Am. **2**: 176. 1840.

Polygonatum biflorum γ giganteum Wood, Bot. & Flo. 346. 1870.

Stems 20 dm. or more in height, 18 mm. in diameter near the base, the lower naked portion about 9 dm. high; upper portion carrying about twenty-eight sessile or subsessile leaves, which are round-ovate or oval (30–37 mm. wide by 60–90 mm. long), with about fifty-three more or less conspicuous nerves; peduncles flat, 2 mm. wide by 90 mm. in length, rigid; pedicels 25 mm. or less, subequal; flowers usually four (two to five), 14–16 mm. long by 4–6 mm. wide; fruit 20 mm. in diameter ripening fifteen seeds, 5 mm. wide. [PLATE 18.]

Moist elder thickets. MICHIGAN: Rochester, June, 1914, *Farwell 3473*. The hyaline subulate bracts of the pedicels, which in the other species are small (2 mm. long) and early deciduous, are in this variety large (4–8 mm. long) and persistent, at least in some cases.

The author wishes to thank Miss Mary A. Day, of the Gray Herbarium, most heartily for transcripts of the original descriptions of Walter and Willdenow and for a sketch of Willdenow's plate of *C. pubescens* which is herewith reproduced for comparison; for a like purpose a photograph of the narrow-leaved plant (*P. biflorum*) collected by Dr. Rusby is also reproduced.

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Explanation of plates 12-18

PLATE 12

Polygonatum pubescens (Willd.) Pursh. From photograph of Willdenow's plate 45 in Hort. Berol.

PLATE 13

A. *Polygonatum pubescens* (Willd.) Pursh. Photographs of specimens from Keweenaw Peninsula, *Farwell 380*, and from near Rochester, *Farwell 3624*, Michigan. B. *Polygonatum pubescens cuneatum* (Greene) Farwell. Photographs of specimens from near Detroit, *Farwell 380c*, and from the Keweenaw Peninsula, *Farwell, 3909*, Michigan.

PLATE 14

A. *Polygonatum boreale* Greene. Photographs of specimens from Keweenaw Pensinula, *Farwell 380a*, and from near Ypsilanti, *Farwell 380b*, Michigan. B. *Polygonatum boreale australe* Farwell. Photograph of specimens from near Detroit, Michigan, *Farwell 480d*.

PLATE 15

A. *Polygonatum biflorum* Walt. Photograph of a specimen from Franklin, New Jersey, *H. H. Rusby*. B. *Polygonatum biflorum virginicum* (Greene) Farwell. Photograph of specimens from Parkedale Farm, Michigan, *Farwell 3682*.

PLATE 16

A. *Polygonatum biflorum ovatum* Farwell. Photograph of specimens from near Rochester, Michigan, *Farwell 3674*. B. *Polygonatum ellipticum* Farwell. Photograph of specimens from near Rochester, Michigan, *Farwell 3673*.

PLATE 17

A. *Polygonatum canaliculatum* (Willd.) Pursh. Photograph of specimens from Parkedale Farm, Michigan, *Farwell 3677 1/2*. B. *Polygonatum canaliculatum americanum* (Hook.) Farwell. Photograph of specimens from near Rochester, Michigan, *Farwell 3675*.

PLATE 18

Polygonatum canaliculatum giganteum (Dietr.) Farwell. Photographs of specimens from Parkedale Farm, Michigan, *Farwell 3473*.

The genus Plagiochasma and its North American species *

ALEXANDER W. EVANS

(WITH EIGHT TEXT FIGURES)

HISTORICAL INTRODUCTION

Of the various Marchantiaceae occurring in North America the genus *Plagiochasma* has long been in especial need of critical study and revision. It is hoped that the present paper may clear up some of the confusion and misunderstanding regarding it, although the writer admits that further work will be necessary before our knowledge of the species can be considered at all complete. Prolonged observation in the field under varying conditions of light and moisture is especially to be recommended, while further collection of material, particularly in fruiting condition, is much to be desired. Fortunately dried specimens are more satisfactory for study than in most genera of the thallose liverworts, even if they can never take the place of material properly fixed and preserved.

The genus *Plagiochasma* Lehm. & Lindenb., as originally proposed by its authors in 1832 (**17**, p. 13), contained two undescribed species from Nepal, *P. cordatum* and *P. appendiculatum*. The first of these should be regarded as the type of the genus. Four years later Lehmann (**16**) published another genus, *Anthrocephalus*, which was likewise based on an undescribed species from Nepal, *A. nepalensis*. In 1838 Nees von Esenbeck (**26**, pp. 33, 40) accepted both of these genera. He pointed out the fact, however, that *Aytonia rupestris* Forst. was referable to *Plagiochasma*, and he added a new species, *P. peruvianum* Nees & Mont., to this genus. *Aytonia rupestris*, which was published in 1776, was based on material collected by its authors on the island of Madeira, but Nees von Esenbeck was able to extend its known range to the island of Corfu, in Greece, citing specimens collected by Spathys. Even at the time he wrote the species had received many names, but he discarded them all and renamed the plant *P. Aitonia* Lindenb. & Nees.

* Contribution from the Osborn Botanical Laboratory.

Between 1838 and 1846 Sassi (**27**) proposed *Anthrocephalus italicus* as a new species, his material having been collected near Finale in Liguria, and the following species of *Plagiochasma* were published: *P. Rousselianum* Mont. (**23**, p. 334, *pl. 9, f. 1*), of western Algeria; *P. chlorocarpum* (Nees & Mont.) Mont. (**24**, p. 59), of Chile; and *P. validum* Bisch. (**3**, p. 56, *pl. 56, f. 2753*), also of Chile. The number of species was thus increased to two in *Anthrocephalus* and to seven in *Plagiochasma*.

In 1846 the part of the Synopsis Hepaticarum which treated the Marchantieae appeared (**11**, pp. 511–521) and the authors of this important work showed that the genus *Anthrocephalus* was based on poorly developed specimens of a *Plagiochasma*, which they renamed *P. Colsmannianum* Lehm. & Gottsche, thus discarding Lehmann's specific name *nepalensis* altogether. For some reason they make no mention of *A. italicus*, possibly because Sassi's work was unknown to them. In addition to *P. Colsmannianum* and the seven species of *Plagiochasma* already known they include the following species in the genus: *P. intermedium* Lindenb. & Gottsche, of Mexico; *P. australe* (Tayl.) Nees, of New Zealand; *P. limbatum* (Tayl.) Nees, of Ascension Island; *P. elongatum* Lindenb. & Gottsche, of Mexico; and *P. mexicanum* Lindenb. & Gottsche, also of Mexico. They thus increased the total number of species to thirteen.

In 1849 a posthumous work of Griffith was published in which four news species of *Plagiochasma* from India were described (**12**, pp. 330, 331, 337, *pl. 65, 68, 69e*), namely: *P. paradoxum* Griff., *P. pedicellatum* Griff., *Anthrocephalus polycarpon* Griff., and *A. megacarpon* Griff. In 1856 Sullivant (**38**, p. 688, *pl. 6*) published *P. Wrightii*, a new species from Texas. In 1859 DeNotaris (**5**, p. 476, *pl. 1*) showed that *Anthrocephalus italicus* was clearly a species of *Plagiochasma* and transferred it to the latter genus under the name *P. italicum*. In 1863 Gottsche (**10**, p. 266) described a new species of *Plagiochasma*, *P. crenulatum*, from Mexico. In 1869 Austin (**1**, p. 229) described, as a new species, *P. erythrospermum* Sulliv., from the Rocky Mountains.

In 1868 Lindberg (**20**, p. 291) revived the generic name *Aytonia* of Forster and secured a number of followers in both Europe and America. He spelled the name "*Aitonia*," which was

perhaps justifiable, both spellings having been used by the original authors. In 1874, Dumortier (**7**, p. 148) discarded both *Plagiochasma* and *Aytonia* and applied the name *Otiona* of Corda to the genus. In 1877 Trevisan (**39**, p. 436) revived the name *Rupinia* of the younger Linnaeus. In 1894 Le Jolis (**19**, pp. 109–116) gave excellent reasons for discarding the names *Aytonia*, *Otiona*, and *Rupinia*, and for retaining the name *Plagiochasma*. This course is now advocated by both Stephani and Schiffner, who included *Plagiochasma* in their proposed lists of *nomina conservanda* presented at the International Botanical Congress of Brussels in 1910. The name *Plagiochasma* is therefore used in the present paper.

In 1881 Leitgeb (**18**, p. 51) showed that *P. Rousselianum* belonged in the genus *Clevea*, proposed by Lindberg in 1868, and the species is now known as *C. Rousseliana* (Mont.) Leitg. In 1899 Howe (**14**, p. 39) showed that *P. erythrospermum* was a synonym of *Clevea hyalina* (Sommerf.) Lindb. Between 1881 and 1898 the following species of *Plagiochasma* were published (some of them under the name *Aitonia*): *A. subplana* Spruce and *A. lanigera* Spruce (**32**, pp. 567, 568), both of Ecuador; *A. extensa* Steph., of Australia (**33**, p. 17); *A. eximia* Schiffn., *A. Fischeriana* Steph., and *A. microcephala* Steph. (**34**, pp. 300, 301) all three of Africa; *A. fissisquama* Steph. of China (**35**, p. 209); *A. japonica* Steph., of Japan (**36**, p. 54); and *P. pterospermum* Massal., of China (**21**, p. 46, *pl. 13, f. 18*). The various species added to the genus since the Synopsis Hepaticarum increased the total number to twenty-eight.

In 1898 Stephani (**37**) published the last general account of *Plagiochasma* in his Species Hepaticarum. With the exception of Griffith's species, three of which he mentions but does not describe on account of the lack of available material for study, he recognizes as valid all the species previously published. He intimates, however, that *P. pterospermum* is probably a synonym of *P. fissisquamum*. Besides transferring to *Plagiochasma* the various species described under *Aitonia* he restores to *P. Aitonia* and *P. Colsmannianum* their original specific names and describes them as *P. rupestre* and *P. nepalense* respectively. He likewise proposes the following seven species as new: *P. dschallanum*, *P. tenue*, *P.*

algericum, *P. Beccarianum*, and *P. Schimperi*, all from Africa; *P. coerulescens* Nadeaud, from Tahiti; and *P. brasiliense*, from Brazil. Since 1898 the following new species of *Plagiochasma* (or *Aytonia*) have been published: *Aytonia Evansii* Haynes and *A. jamaicensis* Haynes, both from Jamaica (13); *P. abyssinicum* Gola, from Abyssinia (9, p. 62); and *P. articulatum* Kashyap, from India (15, p. 320, *f. 8*). It should be noted further that *P. italicum* was reduced to a synonym of *P. rupestre* by K. Müller in 1907 and that this reduction was sanctioned by Schiffner (25, pp. 252, 254). In the review of the literature just given no allusion is made to papers which simply record extensions of range of individual species.

If, now, the four species of Griffith are ignored and the reduction of *P. italicum* to synonymy is accepted, the seven species added by Stephani in 1898 and the four subsequently published increase the total number of species of *Plagiochasma* to thirty-four. Of these species *P. rupestre* has been recorded from various stations in Europe, Asia, and Africa, and *P. elongatum* from both North America and Asia, while the others are distributed as follows: Asia, seven species; Africa, ten; North America, six; South America, six; Australia and the islands of the Pacific, three.

The genus is most at home in arid portions of the tropics, many of the species growing on calcareous rocks. *P. rupestre*, however, extends as far north as the Mediterranean portions of Europe and *P. australe* (as already noted) was based on New Zealand material. On account of the dry habitats the sperms often fail to reach the archegonia, and even where fertilization takes place the normal development of carpocephala and sporophytes may be prevented by periods of drought. Immature and abnormal carpocephala due to such causes have produced much of the confusion in the interpretation of the genus and its various species.

MORPHOLOGY OF THE GENUS

Our knowledge of the morphology of *Plagiochasma* is largely based on the work of Leitgeb (18, pp. 63–68, *pl. 1*), although later writers have added important details. For a resumé of the work done on the genus the Inter-Relationships of the Bryophyta by Cavers may be consulted (4). Recent writers agree in placing

Plagiochasma in Leitgeb's group Operculatae (or its equivalent) of the Marchantiaceae. It represents the most simply organized member of the group, but there is a strong tendency at the present time to consider it reduced rather than primitive.

The species of *Plagiochasma* grow in depressed and intricate mats. The thallus is remarkably uniform in structure throughout the genus and shows clearly the usual differentiation into an epidermis, a photosynthetic layer with intercellular spaces, and a compact ventral layer, from the lower surface of which arise the ventral scales and the rhizoids. The thallus is sometimes continuous in its growth, maintaining the same width, and sometimes seems to be divided into a succession of joints, each joint springing from the apex of an older joint and rapidly increasing in width. According to Leitgeb this condition is not due to apical innovations but simply to the fact that the growth of the thallus is subject to interruptions, the new portions being narrower when the growth is first resumed. According to Kashyap, however, true apical innovations occur in *P. articulatum*. In addition to the usual branching by dichotomy, in which both branches are alike, the thallus often bears ventral adventive branches, which broaden out rapidly from a stalk-like base. The authors of the Synopsis Hepaticarum (11, pp. 511–521) supposed that these branches were never produced by species in which the thallus was jointed and they therefore divided the genus into two sections, as follows: § 1. Frons ex apice cordato articulatim innovans; § 2. Frons e ventre innovans, apice saepe subcontinua. Leitgeb showed, however, that *P. intermedium* of § 1 often developed ventral branches, that *P. appendiculatum* of § 2 often appeared jointed, and that the distinction relied upon in the Synopsis was therefore inconstant and to be used with caution.

The epidermis, as in most genera of the Marchantiaceae, consists of a single layer of pale or colorless cells, although the cell-walls are sometimes more or less pigmented with purple. The walls are usually firm but thin and this is true even of the cuticle. The latter, however, sometimes appears thickened, roughened, and slightly opaque, owing to the deposition of a waxy substance on the surface. When this is present the thallus is bluish or glaucous green instead of bright green. Trigones can always be demon-

strated in the epidermis and are often large and conspicuous, but in certain species their size is very variable and depends on external conditions.

The epidermal pores of the thallus as noted by Leitgeb, are of two distinct types. In the first (FIG. 1) the opening is small and often difficult to demonstrate, especially when more or less stopped up by the waxy secretion on the cuticle. Around this small opening there are usually from four to six bounding cells, the radial walls between which are normally more or less thickened. Sometimes one or more of the bounding cells will be divided by a

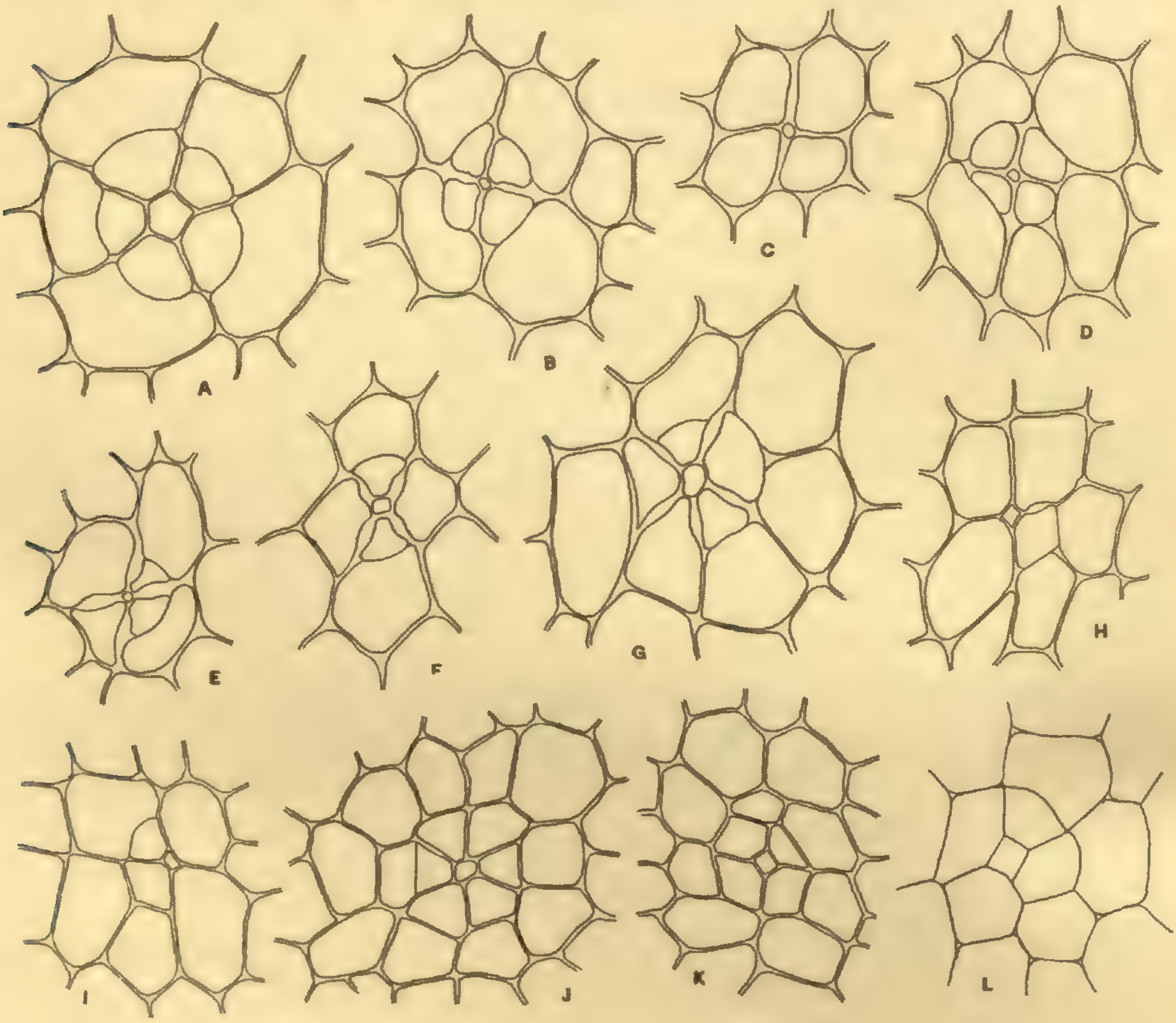

FIG. 1. PLAGIOCHASMA RUPESTRE (Forst.) Steph.

A series of epidermal pores from various specimens, × 300. A. Italy, *D. Lanza*, in V. Schiffner's Hep. Europ. Exsic. No. 10. B, C. Canary Islands, *C. J. Pitard*, in Plant. Canar. No. 762. D. Baja California, *T. S. Brandegee*. E. Puebla, *F. Liebmann*, type of *P. mexicanum*. F. Jalisco, *Barnes & Land 123*. G. Morelos, *Barnes & Land 480*. H. Oaxaca, *F. Liebmann*, type of *P. elongatum*. I. Jalisco, *Barnes & Land 134*. J–L. Arizona, *G. E. Nichols*, the last figure drawn from material cultivated in the laboratory.

periclinal wall (with respect to the pore), and the opening under such circumstances may be described as surrounded by two more or less complete concentric series of cells. The cells surrounding the openings are not elevated and are usually much like the other epidermal cells. When the radial walls between them are slightly or not at all thickened, as is sometimes the case in certain species, the entire pore-structure is very inconspicuous.

In pores of the second type (FIGS. 5–8, A), although the opening itself is not necessarily larger than in pores of the first type, the whole structure is much more evident because it is more or less raised above the general level of the epidermis and because the cells surrounding the opening are in two or more concentric series with six to eight or even more cells in each series. It is convenient to describe these cells, which differ considerably in form from the other epidermal cells, as being arranged in radiating series with two or more cells in each series. In many cases the walls separating these are distinctly thickened. Immediately bounding the opening a circular ridge is present which appears to be formed by the thickened and coalescent inner walls of the surrounding cells. Deutsch (**6**, p. 494, *f. 9*), however, has recently shown that in the very similar pores of *Targionia hypophylla* L. the ridge consists of a circular row of dead and collapsed cells with thickened and highly cutinized walls. Apparently his explanation would apply equally well to the pores of the second type in *Plagiochasma*, and it is sometimes possible to demonstrate the radial walls between the collapsed cells. The presence of this circular ridge in the second type of pore and its absence from the first type is perhaps the most important difference between them.

It will be noted when the pores of *Plagiochasma* are compared with those of other genera of the Marchantiaceae that those of the first type are essentially like the pores found in *Oxymitra* and in the various genera of the Astroporae, while those of the second type find their counterparts in the other genera of the Operculatae, as well as in certain genera of other groups. Both types stand in marked contrast to the complex pores of *Marchantia*, *Preissia*, and *Bucegia*, where the cells surrounding the opening are in several layers. Even in *Plagiochasma*, however, complex pores of the marchantiaceous type are present on the carpocephala.

The photosynthetic tissue contains several layers of intercellular spaces, separated from one another by plates of green cells a single cell in thickness. These spaces, which vary greatly in size in different species, are connected with one another by means of holes through the green partitions, and some of them communicate directly with the outside air by means of the epidermal pores. According to Leitgeb (**18**, p. 64) the thallus first forms primary intercellular spaces or air chambers, each of which has its pore, and these chambers afterwards become divided up by secondary plates of cells which grow out from the primary partitions. Barnes and Land (**2**, pp. 210–213, *f. 17–22*) admit that such a partitioning of chambers in *Plagiochasma* may perhaps occur to a limited extent, but they show clearly that some of the air-spaces without epidermal pores are formed directly, in very young segments, by the splitting apart of cells originally united.

The compact ventral tissue is not highly developed. In the median portion of the thallus it attains a thickness of perhaps ten to twenty cells, but it thins out rapidly on each side until it becomes only one cell thick and forms the ventral walls of the air-chambers. It is composed of thin-walled cells, a few of which contain oil-bodies, but it shows no signs of the slime cavities or the fibrous cells which occur in some of the more complicated Marchantiaceae. Sometimes, but not always, mycorrhiza is present in the ventral tissue, occupying cells in the median portion just below the green tissue. The cells containing the mycorrhiza sometimes have their walls pigmented with purple, but this is not invariably the case.

The rhizoids are of the two types usually found in the Marchantiales and require no especial comment. The ventral scales, however, which are in two regular rows, are unusually well developed and exhibit considerable variety in form and structure, sometimes even in a single species (see FIGS. 2, 3). They show the characteristic division into basal portion and appendage or appendages. The basal portion is ovate to lunulate in outline and is attached by an oblique line extending forward from the median region half way to the margin or beyond. In the apical part it narrows gradually or abruptly into the appendage or appendages, the number of these structures often varying from one to three on

a single thallus. The appendages vary in form from narrowly lanceolate to orbicular, when the genus as a whole is taken into account, and they likewise vary markedly in size. As in other genera of the Marchantiaceae the appendages are the first part of

FIG. 2. PLAGIOCHASMA RUPESTRE (Forst.) Steph.

A series of ventral scales (or their appendages) from specimens collected in various parts of Europe and the Atlantic Islands. A, B. Italy, *D. Lanza*, in V. Schiffner's Hep. Europ. Exsic. No. 10. C, D. Madeira Islands, *W. Trelease*, × 40. E–G. Canary Islands, *O. Kuntze*, × 27. H. From the same specimen, × 17. I–L. Canary Islands, *C. J. Pitard*, in Plant. Canar. No. 762, × 40. M. Ascension Island, *J. D. Hooker 22*, type of *P. limbatum*, × 27. N. From the same specimen, × 40.

the scale to develop, covering over the embryonic region at the growing point and being gradually pushed into a ventral position by the apical elongation of the thallus. The basal portion and the appendages are usually deeply pigmented with purple, but the color of the appendages in particular often becomes bleached

FIG. 3. PLAGIOCHASMA RUPESTRE (Forst.) Steph.

A series of ventral scales (or their appendages) from various North American specimens. A–F. Arizona, *G. E. Nichols*, × 40, the last three figures drawn from material cultivated in the laboratory. G, H. Arizona, *W. A. Cannon*, × 40. I, J. Baja California, *T. S. Brandegee*, × 40. K, L. Morelos, *C. G. Pringle 15319*, × 40. M–O. Jalisco, *Barnes & Land 123*, × 17. P. Morelos, *Barnes & Land 480*, × 40. Q. From the same specimen, × 17. R. Oaxaca, *F. Liebmann*, type of *P. elongatum*, × 40.

out with age. The scales are a single cell in thickness except near the base. The cell-structure is sometimes uniform throughout, but the marginal cells are sometimes irregular and project as indistinct teeth bearing slime papillae or their vestiges (FIG. 5, D). The cells containing oil-bodies, on account of their small size and lack of pigmentation, form a striking feature of the scales. They are sometimes confined to the basal portion and sometimes occur in the appendages as well.

With regard to the inflorescence certain species of *Plagiochasma* are described as dioicous and others as monoicous, while some are said to be either dioicous or monoicous. Unless the male and female plants grew in separate mats, a dioicous inflorescence would be difficult to demonstrate beyond doubt on account of the fact that the androecia are often borne on ventral branches, which easily become separated and present the appearance of being distinct plants. It is therefore probable that some of the so-called dioicous species are really monoicous. Stephani (**37**, p. 777) mentions an interesting case which shows how variable the inflorescence can be and how easily a hasty observation could lead to error. In the thallus he described he found five joints, the first, second, and fourth of which were male, the third and fifth female. Each joint bore ventral branches, the male joints in most cases bearing female branches and the female joints male branches. Among the ventral branches he found further certain ones which bore both male and female inflorescences in succession and others which forked, one fork being male and the other female. Schiffner (**28**, p. 15) has described material of *P. italicum* in which the inflorescence was equally variable. In both these cases the inflorescence might properly be described as heteroicous, and this term would probably apply to most monoicous species and to many which are supposed to be dioicous.

The antheridia, as in most of the other Marchantiaceae, are grouped in definite discoid inflorescences or androecia, slightly raised above the dorsal surface of the thallus and apparently not affecting its subsequent growth. The androecia vary in outline from circular to more or less crescentic or cordate, with the convex side turned toward the base of the thallus. These crescentic androecia, as Leitgeb notes, should not be confused with the

dichotomous androecia occasionally found in *Lunularia*, where two growing points are involved (18, p. 26). They represent, according to his ideas, a persistence of the two-lobed condition at the apex of an ordinary thallus, where the single growing point lies in the indentation between the lobes. Kashyap (15, pp. 318, 321), however, says that in both *P. appendiculatum* and *P. articulatum* the androecium usually has two growing points and implies that the horseshoe shape is therefore due to a forking. Unfortunately, he presents no conclusive evidence to support his position. The antheridia are of the usual marchantiaceous type. Each one lies at the bottom of a deep depression, the roof of which forms a distinct bluntly conical ostiole with a minute opening at the tip. Between the ostioles the epidermis of the androecium shows numerous pores and these, as recently demonstrated by Kashyap, are of the same type as in the vegetative thallus. In cases where the normal pores are complex and show many radiating series of cells with several cells in each series, the androecial pores tend to be more simple and to show fewer series of cells and fewer cells in each series. A row of delicate and slender scales, usually pigmented with purple, surrounds the androecium.

The carpocephala arise singly or in short median rows from the dorsal surface of the thallus and apparently in most cases neither stop nor interrupt its further elongation. Each carpocephalu mcommonly bears three or four archegonia evenly distributed around its margin (Leitgeb, 18, p. 29) although in *P. appendiculatum*, according to Kashyap, the number is frequently five or six and may be as high as nine. Through the extensive growth of the upper median portion and of the parts adjacent to the archegonia, the latter are displaced to the lower part of the carpocephalum and each one eventually lies at the bottom of a groove which is bounded by two folds of tissue. In case fertilization has taken place the grooves become much deeper through the continued growth of the folds, the edges of which come together and grow inwards toward the developing sporophyte, as originally described and figured by De Notaris in the case of *P. rupestre* (5, p. 480, *pl. 1, f. 20–26*); where the folds meet at their upper ends they form a more or less distinct apiculum or horn. No pseudoperianths of any sort are developed. Around the margin

of the carpocephalum a circle of slender scales (see FIGS. 4, E; 5, E–G; etc.) makes its appearance very early; these scales, according to Leitgeb (**18**, p. 67), are in two series and they show the same purple pigmentation as the androecial scales, becoming bleached out with age. When the capsules have reached maturity the region between the carpocephalum and the thallus undergoes intercalary growth and elongates into a stalk, some of the scales remaining at the base and some being carried up with the carpocephalum. The length of the stalk varies greatly in different species and even in the same species under different conditions. Sometimes it is so short that it scarcely raises the carpocephalum above the thallus. The stalk is remarkable on account of the fact that it possesses no rhizoid-furrow, although it may be irregularly grooved.

With regard to the morphology of the carpocephalum in *Plagiochasma* and in *Clevea*, where similar conditions obtain, the opinions of writers vary. Leitgeb (**18**, p. 29) considered the whole structure a highly developed dorsal outgrowth of the thallus, comparable with the low outgrowths found in *Corsinia*. He based his conception on the continued growth of the thallus after the initiation of the carpocephalum and on the lack of a rhizoid-furrow in the stalk, both indicating that the growing point of the thallus was not involved. He therefore considered that the carpocephalum in these two genera was morphologically different from the very similar carpocephalum found in *Reboulia*, *Sauteria*, and more complex forms, where the initiation of the carpocephalum brought the growth of the thallus to an end and where the stalk showed one or two rhizoid-furrows. In these cases he considered that the carpocephalum represented a modified shoot (or shoot-system) in which the growing point of the thallus was directly involved. Leitgeb's views regarding the androecium were very similar. Not only in *Plagiochasma* but also in *Reboulia* and other genera, where the development of the androecium failed to stop the growth of the thallus, he considered the structure a mere dorsal outgrowth and therefore morphologically different from the androecium in *Preissia* and related genera, where it represented a modified shoot.

Goebel (**8**, p. 46) has recently pointed out that these ideas

involve certain difficulties. He emphasizes the improbability of having the male and female inflorescences morphologically different in a single genus, such as *Reboulia*, or in a group of related genera, and he brings out the fact that if the carpocephalum of *Plagiochasma* is really a dorsal outgrowth, as Leitgeb claimed, then its scales would have to have a different significance from the very similar scales found on a carpocephalum which represents a branch system. In the latter case the scales are modified ventral scales, homologous with those found on an ordinary thallus. In *Plagiochasma*, however, the scales if considered homologous with the ventral scales would imply an inversion of the dorsi-ventrality of the thallus to account for their dorsal position; if considered morphologically different from the ventral scales, they would have to be regarded as developed from structures normally present on the dorsal surface, such as the hairs found in certain species of *Riccia*, or the slime-papillae which occur in the cupules of *Marchantia*. Neither of these interpretations seems plausible.

Goebel shows further (**8**, pp. 85–88) that these difficulties of interpretation are avoided if such genera as *Reboulia* and *Plagiochasma* are considered as reduced from the more complex *Marchantiaceae* rather than as primitive forms from which the more complex genera have been evolved. In *Marchantia*, for example, where the complexity perhaps reaches its highest expression, both the androecium and the carpocephalum represent stalked branch-systems, the sexual organs arising in acropetal succession on the evident branches. A first indication of reduction appears when the branches lose their distinctness although the acropetal succession of the sexual organs remains apparent. This is seen in the androecium of *Preissia*. A second indication is a reduced development of the stalk, leading to its final disappearance, as seen in the androecia of *Conocephalum* and its allies. A third step in the reduction, according to Goebel's account, is a change in the position of the inflorescence, which is perhaps caused by a very early appearance of an apical innovation. This may occur even in inflorescences which retain their stalks. In many cases such an innovation is not started until the inflorescence is already established, when it shows its character clearly as a new shoot broadening out from a narrow base. Such a condition is evident in the

carpocephalum of *Reboulia* and also in the curious *Plagiochasma articulatum*, according to Kashyap's account (15, p. 320). If, however, the innovation starts much earlier it might seem to continue the growth of the thallus without an interruption and thus to displace the inflorescence to an apparently dorsal position. The latter would still represent a modified shoot, the scales would still be homologous with ventral scales, and a thallus which showed a median dorsal row of such inflorescences would really be a sympodium. The change in position just described is clearly seen in the androecium of *Reboulia* and in both the male and female inflorescences of most species of *Plagiochasma*. In the case of the androecium of *Bucegia*, recently investigated by Schiffner (30), all gradations in the process have been demonstrated.

It is perhaps not necessary to assume that the carpocephalum in *Plagiochasma* actually involves the growing point of the thallus and that a new growing point must be differentiated before the growth can be continued. If the important part played by intercalary growth in the development of the carpocephalum is taken into account such an assumption becomes superfluous. Even in such complex carpocephala as those of *Marchantia* the growth of the stalk and of the upper part leading to the displacement of the archegonia to the lower surface is intercalary in character. In *Reboulia*, after the earliest rudiment of the carpocephalum is laid down in the young segments derived from the growing point, the later development is entirely intercalary, as Leitgeb himself admits (18, p. 31), and the growing point, carried upward by the elongating stalk, plays no part whatever in the process. In *Plagiochasma* the first beginning of the carpocephalum is developed from young segments just as in *Reboulia*, and from this rudiment the mature structure develops by intercalary growth in the same way. The mere fact that the growing point is not carried upward by the elongating stalk but continues directly the growth of the thallus does not invalidate the homology of this carpocephalum with that of *Reboulia*. In both cases the structure owes its initial stages to the activity of the growing point of the thallus and its later stages to intercalary growth, and in neither case does the growing point play any active part in these later stages. Of course what is here said about the carpocephalum would apply in most respects to the androecium as well.

In case the growing point of the thallus is not used up in the development of the inflorescence the latter becomes a lateral or dorsal branch, and the shoot which bears a series of such inflorescences would be a monopodium and not a sympodium. Such a change from a sympodium to a monopodium would not be unique. Goebel (**8**, p. 91) quotes similar examples from the inflorescences of the Boraginaceae and from the vegetative shoots of the Vitaceae. And the further reduction from such a monopodium through *Corsinia* to *Riccia*, where the sexual organs are not in distinct inflorescences and where the intercalary growth so prominent in the carpocephala of *Reboulia* and *Plagiochasma* has become largely or wholly eliminated, would be easily intelligible.

In classifying the species of *Plagiochasma* Stephani (**37**) lays a great deal of stress upon the shape of the carpocephalum. He divides the genus into two groups, "*a*" and "*b*." In "*a*" the carpocephalum is said to be more or less convex; in "*b*," more or less excavated at the vertex. From the writer's observations this distinction is not constant. In at least one species which Stephani places in division "*a*," namely *P. japonicum*, the carpocephala examined were distinctly concave, and even if this condition should be proved exceptional its occasional presence would invalidate Stephani's classification. It is quite possible that the form of the carpocephalum is influenced by external condition, although no experimental evidence can be brought forward to support this idea.

The sporophyte of *Plagiochasma* is described in its essential features by Leitgeb (**18**, p. 67). He calls attention to its well-developed foot and scarcely evident stalk and to the fact that the wall of the capsule consists of a single layer of cells except in the apical portion, which shows a circular region three cells thick. This he regards as a rudimentary lid although it does not separate at maturity as a typical lid would do. The capsule, in fact, dehisces irregularly and leaves behind a shallow urn with indefinite teeth or lobes around the rim. The cells of the capsule wall are destitute of the annular or half-annular thickenings found in so many of the Hepaticae. Some of them show more or less distinct trigones, but many of them are thin-walled throughout. The

very rudimentary lid was apparently considered by Leitgeb a sufficient reason for placing *Plagiochasma* among his Operculatae. Solms-Laubach (29, p. 12) has shown, however, that in Leitgeb's group Astroporae an equally definite lid is developed but that it is easily overlooked on account of the thickenings in the cells of the capsule wall. In spite of this fact the lack of annular thickenings in the capsule wall and the structure of the photosynthetic layer of the thallus would seem sufficient to exclude *Plagiochasma* from the Astroporae and to place it in the same group as *Reboulia*, *Grimaldia*, and *Neesiella*, whatever this group may be called.

Stephani (37, p. 776) describes the spores as large, yellowish, tetrahedral, and loosely reticulate on the convex face with high and rough lamellae. The tetrahedral form is of course due to the original arrangement of the spores in the tetrad resulting from the division of the spore mother cell. One face of each spore, the spherical or convex face, represents a fourth of the original surface of the tetrad (see FIGS. 4, F; 5, H; 7, H; 8, G). The other three faces, the plane faces, represent the regions of contact with the three other spores of the tetrad (see FIGS. 4, G; 8, H). Throughout the genus a broad border is formed where the three plane faces meet the spherical face, and three narrow ridges are developed along the edges of the pyramid formed by the three plane faces. In order to gain a clear idea of the reticulum described by Stephani it is advisable to pass in review a large series of spores and to select for study those which show the spherical face plainly and those in which the apex of the pyramid is turned toward the eye of the spectator. If this is done the meshes of the reticulum will be observed in their most diagrammatic position, and it will be seen that the reticulum extends over both spherical and plane faces. A regular reticulum has been observed by the writer in all the the species examined. Sometimes, however, in some or all of the spores in a capsule, the reticulum will be incomplete owing to the partial development of the bounding ridges. Since this condition occurs in species where a normal reticulum is usually developed it can not be used as a distinguishing peculiarity. The spores of *Plagiochasma*, in fact, in contrast to many genera of the Hepaticae, yield no very helpful differential characters in separating species.

The elaters in the majority of cases are like those found in other

Hepaticae and consist of long tapering cells with thin walls strengthened by from two to four spiral bands of thickening. Two interesting modifications, however, should be noted. In the first, the spiral bands, which are entirely free from one another in most elaters, are coalescent by means of one or more longitudinal bands (FIG. 5, I). In the second, no spirals at all are present but the wall of the elater is uniformly thickened and the cavity reduced to a narrow median canal (FIG. 8, I). Coalescence of the type found in the first modification seems to be unusual. It was first detected by Miyake (**22**, p. 223, *pl. 3, f. 3*) in the remarkable *Makinoa crispata* (Steph.) Miyake, of Japan, but it has since been observed by Schiffner (**29**, p. 24) in *Neesiella rupestris* (Nees) Schiffn., a widely distributed species of Europe and North America, and probably occurs in other genera. The second modification is apparently confined to the genus *Plagiochasma*. It was first noted by Gottsche in *P. intermedium* (**10**, p. 264) and is mentioned by Stephani as one of the characteristic features of *P. japonicum* (**36**, p. 84). Its occurrence has likewise been recorded by Kashyap (**15**, p. 320) in the case of *P. appendiculatum* and *P. articulatum*, and the writer has observed it in *P. eximium*. Although the uniform thickening of the elater-wall has been considered a good specific character, it is not a constant feature and must be used with caution. Even in *P. intermedium*, where it is certainly the usual condition, Leitgeb (**18**, p. 68) failed to find it in the material which he examined. In the case of *P. japonicum* Massalongo (**21**, p. 48, *pl. 13, f. 19*) has described and figured a var. *chinense*, based on Chinese specimens collected by Father Giraldi, in which some of the elaters showed rudimentary spiral bands, although most were of the more solid type. Miss Haynes, also, in a series of unpublished drawings based on Japanese material of the same species, collected by T. Yoshinaga, has represented elaters in which poorly developed and irregular bands were present. In *P. eximium* some of the elaters show spiral bands and others uniform thickenings and there are various gradations between them. In *P. appendiculatum* the solid type is said to be less common than in *P. articulatum*, and Kashyap associates it with exposure to dryness during the development of the capsule. In spite of these variations there are certain species

in which a uniform thickening has never been observed, so that it is allowable to associate this peculiarity with certain species, even if they may sometimes develop elaters of the usual type.

DESCRIPTION OF THE NORTH AMERICAN SPECIES

The seven North American species with their known ranges, according to published records, are the following: *P. crenulatum*, Mexico; *P. elongatum*, Mexico and China; *Aytonia Evansii*, Jamaica; *P. intermedium*, Mexico and Guatemala; *Aytonia jamaicensis*, Jamaica; *P. mexicanum*, Mexico; and *P. Wrightii*, Texas. In the writer's opinion, however, *P. elongatum*, *Aytonia Evansii*, and *P. mexicanum* represent synonyms of the widely distributed *P. rupestre*. This reduction to synonymy would diminish the total number of North American species to five, if it were not for a Mexican species proposed as new, which raises the number to six. In certain cases it has proved possible to extend the known ranges of individual species to a considerable extent. The six species recognized in the present paper may be distinguished as follows:

Key to the North American species

Epidermal pores of the first type (see p. 264), inconspicuous, not elevated, usually surrounded by from four to six cells. — 1. *P. rupestre* (p. 277).

Epidermal pores of the second type (see p. 265), conspicuous, elevated, usually surrounded by six or more cells.

Elaters with spiral bands of thickening.

Appendages of ventral scales almost as long as the scales, ovate to orbicular, abruptly acute or apiculate. — 2. *P. crenulatum* (p. 288).

Appendages of ventral scales much shorter than the scales, ovate, apiculate. — 3. *P. jamaicense* (p. 292).

Appendages of ventral scales lanceolate to ovate, acute or obtuse. — 4. *P. Wrightii* (p. 294).

Appendages of ventral scales subulate, acuminate. — 5. *P. Landii* (p. 298).

Elaters usually with uniformly thickened walls showing no signs of spiral bands of thickening. — 6. *P. intermedium* (p. 301).

1. PLAGIOCHASMA RUPESTRE (Forst.) Steph.

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Plagiochasma elongatum Lindenb. & Gottsche; G. L. & N. *l. c.* 519. 1846.
Plagiochasma mexicanum Lindenb. & Gottsche; G. L. & N. *l. c.* 519. 1846.
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Aitonia italica Lindb. Not. F. et Fl. Fenn. **9**: 291 (footnote). 1868.
Otionia rupestris Dumort. Hep. Europ. 148. 1874.
Otionia italica Dumort. *l. c.* 149. 1874.
Rupinia italica Trevis. Rend. Ist. Lomb. II. **7**: 785. 1874.
Rupinia rupestris Trevis. Mem. R. Ist. Lomb. III. **4**: 437. 1877.
Rupinia mexicana Trevis. *l. c.* 437. 1877.
Rupinia elongata Trevis. *l. c.* 437. 1877.
Rupinia limbata Trevis. *l. c.* 437. 1877.
Rupinia australis Trevis. *l. c.* 437. 1877.
Aitonia lanigera Spruce, Trans. Bot. Soc. Edinburgh **15**: 568. 1885.
Aitonia australis Steph. Hedwigia **28**: 129. 1889.
Aytonia elongata Underw. Bot. Gaz. **20**: 66. 1895.
Aytonia mexicana Underw. *l. c.* 66. 1895.
Plagiochasma rupestre Steph. Bull. Herb. Boissier **6**: 783. 1898.
Plagiochasma lanigerum Steph. *l. c.* 188. 1898.
Aytonia Evansii Haynes, Bull. Torrey Club. **34**: 57. *pl. 5.* 1907.

Thallus pale green and glaucous above with a narrow purple border, plane or somewhat canaliculate, strap-shaped, sometimes forking, sometimes innovating at the apex or with ventral branches, margin undulate, scarcely or not at all crispate, mostly 1–2 cm. long, and 5–7 mm. wide, thickness of thallus about one tenth the width; epidermis composed of thin-walled cells with small trigones and a thin minutely roughened cuticle with a waxy deposit, the cells mostly 18–30 μ in diameter; pores not elevated, small, surrounded by four to six cells in a single series or in an incomplete double series, radial walls usually distinctly thickened; aeriferous layer about one half the thickness of the thallus in the median portion, fairly compact with the air-spaces a little wider than the green cells, tending to extend at right angles to the epidermis; ventral scales deep purple, obliquely lunate to ovate, entire, with a few scattered cells containing oil-bodies, gradually narrowed into one or two (very rarely three) ovate-lanceolate to lanceolate or subulate appendages, acute to acuminate at the apex, slightly or not at all constricted at the base, entire: inflorescence monoicous: ♂ inflorescence on a small ventral branch or on an ordinary branch: ♀ receptacles borne singly or in a median longitudinal series; peduncle short, mostly 3 mm. long or less; carpocephalum concave at the apex, with two or three apiculate lobes, maturing two or three sporophytes; scales of carpocephalum abundant, narrowly subulate with elongated filiform points, entire: spores yellowish brown, 70–90 μ in diameter, minutely rugulose, reticulate, spherical face mostly with twelve to fifteen meshes, plane faces usually with three or four meshes, the meshes on both spherical and plane faces often incomplete; elaters mostly 250–400 μ in length and about 10 μ in diameter, with two to four spirals, sometimes more or less coalescent. [FIGS. 1–4.]

The following specimens have been examined:

NEW MEXICO: Organ Mountains, Filmore County, altitude 1800 m., July, 1897, *E. O. Wooton.*

ARIZONA: without definite locality or date, *H. H. Rusby;* Santa Catalina Mountains, April, 1913, *W. A. Cannon;* Soldier's Canyon, Santa Catalina Mountains, September, 1913, *G. E. Nichols.*

BAJA CALIFORNIA: without definite locality or date, *T. S. Brandegee 25.*

DURANGO: Tejamén, August, 1906, *E. Palmer 473, 474;* city of Durango and vicinity, 1896, *E. Palmer 709* (mixed with *Targionia hypophylla* L.).

JALISCO: wet banks and rocks, Barranca de Oblatos, Guadalajara, September, 1908, *Barnes & Land 122, 123, 134.*

MORELOS: San Antonio Falls, Cuernavaca, October, 1908, *Barnes & Land 480;* near Cuernavaca, July, 1908, *C. G. Pringle 15319.*

OAXACA: Comaltepec, Chuapam, *F. Liebmann* (type of *P. elongatum*); Barranca San Luis, April, 1906, *C. Conzatti 1619.*

PUEBLA: San Baltanzan, near Puebla, May, 1909, *J. Nicolas 2;* San Lorenzo Tehuacan, *F. Liebmann* (type of *P. mexicanum*).

SAN LUIS POTOSI: near San Luis, 1878, *Parry & Palmer 1016.*

ZACATECAS: near Conception del Oro, August, 1904, *E. Palmer 307.*

JAMAICA: on banks near Portland Gap, Blue Mountains, July, 1903, *A. W. Evans 213* (type of *Aytonia Evansii*); on banks and rocks near Content Gap, September, 1906, *A. W. Evans 613.*

BRAZIL: Rio Janeiro, April, 1875, *Glaziou 7402* (listed by Spruce as "*Fimbriaria* sp." in Rev. Bryol. **15**: 34. 1888); Rio Grande de Sul, August, 1905, *A. Bornmüller 4994* (distributed under a manuscript name of Stephani).

ECUADOR: near Baños, Andes, altitude 2,000 m., *R. Spruce* (distributed in Hepaticae Spruceanae as "*Aitonia lanigera*" and probably representing a part of the original material).

GALAPAGOS ISLANDS: Abingdon Island, September, 1906, *A. Stewart 8676;* Charles Island, October, 1906, *A. Stewart 940.*

PERU: Ollantaytambo, July, 1911, *H. W. Foote* (listed by the writer as "*P. chlorocarpum*" in Trans. Conn. Acad. **18**: 298. 1914).

BOLIVIA: near Mapiri, January, 1893, *M. Bang 1748* (listed by Rusby as "*Aitonia valida*" in Mem. Torrey Club **6**: 129. 1896); Pelichuco, altitude 3350 m., May, 1902, *R. S. Williams 2728;* lower Pelichuco Rio, altitude 900 m., April, 1902, *R. S. Williams 2738.*

ARGENTINA: Sierra de Ventána, January, 1892, *R. Hanthal 61.*

CHILE: Desert of Atacama, September–October, 1890, *T. Morong.*

ITALY: on walls near Voltri, Liguria, *J. Baglietto* (distributed in Rabenhorst's Hep. Europ. No. 85, as *P. italicum*); near Palermo, Sicily, *D. Lanza* (distributed from specimens cultivated at Prague, Austria, in Schiffner's Hep. Europ. Exsic. No. 10, as *P. italicum*).

MADEIRA ISLANDS: without definite localities or dates, *G.*

Raddi (type of *Reboulia maderensis*), *G. Don;* near Funchal, 1858, *Johnson;* Como do Lobos, August, 1896, *W. Trelease.*

CANARY ISLANDS: Palma, 1815, *C. Schmidt;* February, 1888, *O. Kuntze;* Bocco de Bufadero, Teneriffe, January, 1906, *C. J. Pitard* (distributed in Plantae canarienses, No. 762).

CAPE VERDE ISLANDS: Green Mountains, St. Vincent, date and collector unknown.

ASCENSION ISLAND: without definite locality or date, *J. D. Hooker 22* (type of *Jungermannia* [*Fegatella*] *limbata*).

ST. HELENA: without definite locality or date, *Lieut. Houghton 33*.

ABYSSINIA: locality, date, and collector unknown.

TRANSVAAL: Müller's Farm, *MacLea* (distributed in Rehmann's Hepaticae austro-africanae, No. 32, as "*Plagiochasma muricatum* Steph.," but probably representing a part of the type material of *P. tenue*).

AUSTRALIA: Swan River, West Australia, 1846, *T. Drummond.*

NEW ZEALAND: without definite locality or date, *J. D. Hooker* (type of *Jungermannia* [*Fegatella*] *australis*).

Aside from several other localities in Italy and the Atlantic Islands, *P. rupestre* has been recorded from Greece, from Dalmatia, from southern France and Corsica, from Portugal, from Cape Colony, and from Asia Minor. Whether the plant from Schen-si, China, collected by Father Giraldi in 1896 and described by Massalongo (**21**, p. 49) under the name *P. elongatum β ambiguum*, belongs here or not cannot be decided from lack of specimens. According to the description, which tells nothing about the epidermal pores, the spores are subrugose (or rugulose) and not reticulated. Such a peculiarity would exclude the plant not only from *P. rupestre* but probably from the genus *Plagiochasma* altogether. The author intimates, however, that the spores may not have been mature, so that no definite conclusions can be drawn from them.

Although *P. rupestre* has not been considered an especially variable member of the Marchantiaceae, it nevertheless exhibits considerable diversity in size, in color, in the distribution of its male and female inflorescences, and in the structure of certain of its organs and tissues. Some of this diversity at least is due to

external conditions. The variations in size and in inflorescence have already been considered. With regard to color the thallus is sometimes green throughout but is usually more or less pigmented with purple. The pigmentation may be confined to the ventral scales, but it usually affects also the ventral surface from the scales to the edge and a narrow border on the dorsal surface; sometimes, in fact, the entire dorsal surface may be more or less colored, although this condition is rare.

The structure of the epidermis and its pores is also worthy of comment (FIG. 1). Not only do the epidermal cells vary markedly in size, but their walls differ in thickness and the trigones are sometimes conspicuous, with straight or convex sides, and sometimes hardly to be made out at all. The waxy layer on the cuticle, moreover, is sometimes so thick and opaque that it is difficult to see the epidermal cells beneath. The epidermal pores escaped the observation of the early authors, and even Nees von Esenbeck (**26**, p. 45) and DeNotaris (**5**, p. 477) said that no pores were present. Apparently Voigt, in 1879, was the first to detect them (**40**, p. 747, *pl. 9, f. 24, 25*). In *P. Aitonia* he says that the pores are the smallest known to him, that the cells bounding the opening differ from the other epidermal cells only in their thickened radial walls, that the inner angles of these cells are often cut off by walls thus forming two circles (of four cells each), and that the inner cells of these circles are often so small that they can easily be overlooked. In *P. italicum* he says that the pores are larger, that the radial walls are scarcely thickened, and that the inner cells of the two concentric circles are almost always distinct. His figure of the surface view, which is said to represent *P. Aitonia*, does not show the radial thickenings very clearly, but his account of the two species which he distinguishes brings out the amount of variation to be expected in *P. rupestre*. In the vast majority of cases the number of cells around the openings varies from four to six. In very rare cases three cells or more than six may be demonstrated. In the accompanying figures the great variations in the size of the opening, in the thickness of the radial walls, etc., are shown. Apparently the degree of thickness which the radial walls show varies with the size of the trigones in the neighboring epidermal cells. In culti-

vated material (FIG. 1, A, L) the cells tend to be large, the trigones to be small, and the radial thickenings to be very inconspicuous, but similar conditions are sometimes present in plants growing naturally, so that no very definite conclusions can be drawn with respect to the causes of such variation.

The older writers laid but little stress on the peculiarities of the ventral scales in distinguishing the species of the Marchantiaceae. Perhaps some of the recent writers have over-emphasized the importance of these characters, but in the genus *Plagiochasma* the scales are often very helpful in the determination of species. They are, however, subject to considerable variation, and this is seen especially well in the case of *P. rupestre.* In their most characteristic form the basal portion of the scale varies from

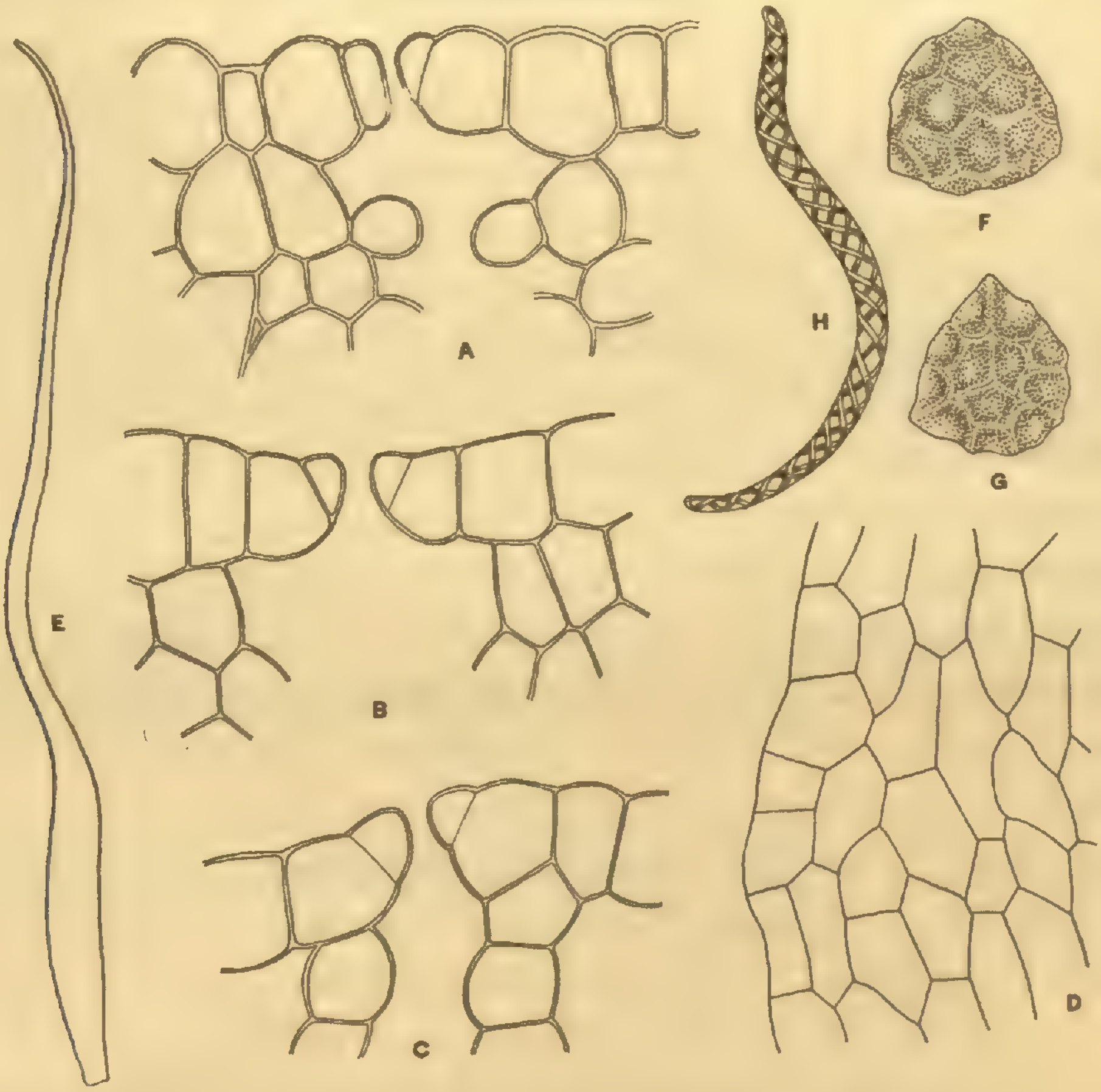

FIG. 4. PLAGIOCHASMA RUPESTRE (Forst.) Steph.

A–C. Epidermal pores, cross-sections, × 300. D. Cells from the margin of a ventral scale, basal portion, × 225. E. Scale from a carpocephalum, × 40. F. Spore, spherical face, × 225. G. Spore, plane faces, × 225. H. Elater, × 225. Figs. A and F–H were drawn from a specimen collected in Jalisco, *Barnes & Land 134;* Fig. B, from a specimen collected in Arizona, *G. E. Nichols;* and Figs. C–E, from a specimen collected in Morelos, *Barnes & Land 480.*

lunulate to ovate, while the appendages, one or two in number, are subulate and acute, without constriction at the base (see FIG. 2, A, B). Sometimes, when only one appendage is present there is no sharp boundary where it passes into the basal portion. The deviations from this characteristic condition are shown most clearly in the form of the appendages, which are sometimes ovate and more or less plicate at the base, and in their apices, which may be acuminate or, on the other hand, obtuse or even rounded, several of these variations being sometimes present on a single thallus or in a single clump (FIGS. 2, 3). The pigmentation of the scales is usually pronounced, although it may be absent in very moist environments and may disappear to a greater or less extent with age. The cells of the scales are fairly uniform throughout (see FIG. 4, D). Some of the marginal cells occasionally project as blunt or sharp denticulations, and in rare cases a distinct marginal tooth is present. It is much more usual, however, for the margin to be quite entire, and the peculiar slime papillae found in some of the other species are so evanescent that they leave no vestiges. The basal portion of the scale shows scattered cells with oil-bodies, and sometimes one or two such cells are to be seen in the appendages. One of the figures by DeNotaris shows a ventral view of a thallus with several scales in position. One of these scales shows four appendages. The writer has never observed so high a number, although three appendages were found in a very few cases.

In reducing *P. italicum* to a synonym of *P. rupestre* Müller calls attention to the fact that Stephani recognizes both species in his Species Hepaticarum. He adds, however, that he has sought in vain to find differential characters separating them, although he has examined specimens under both names in the Stephani herbarium. He found these to be almost exactly alike even in their details. The differences brought out by Stephani are the following: in *P. rupestre*, the dioicous inflorescence, the pore surrounded by five cells, the single narrowly lanceolate and acute appendage of the ventral scales: in *P. italicum*, the monoicous inflorescence, the pore surrounded by four cells, the one or two narrowly triangular appendages with broad bases. It will be seen at once that these differences are based on exceedingly

variable characters, and it is not probable that many writers on the Hepaticae will dissent from Müller's reduction.

In the present paper several other species are considered synonyms of *P. rupestre*, and it might appear at first as if the reduction had been carried on in a somewhat wholesale way. In each case, however, the writer has based his opinion on the careful comparison of type specimens with authentic material of *P. rupestre* from Europe and the Atlantic Islands. It should perhaps be added that most of the species here reduced were proposed at a time when a plant was assumed to represent a new species if it came from a distant or isolated locality. The various species may be discussed in order.

In *P. australe*, which Stephani places just before *P. elongatum*, the following characters are emphasized: the monoicous inflorescence, the androecium being near the carpocephalum, the pore bounded by five cells, the lack of thickenings in the epidermal cells, the two appendages of the ventral scales, abruptly ligulate in outline, shortly acuminate, as long as the scales. In the portion of the type specimen examined some of these characters were not materialized. The cells of the epidermis, for example, although difficult to see on account of the thick and waxy cuticle, had distinct trigones, and the cells bounding the pores were four in number about as often as five. The radial walls, moreover, separating these cells were strongly thickened. With regard to the scales many of them showed a single appendage, and the form of this structure varied from lanceolate to ovate, the apex being acute. Of course these are only slight deviations from Stephani's account, which was based on Australian material collected by F. von Müller, and they are no more than would be expected in a variable species. Nothing was found in the type specimen which would warrant a separation from *P. rupestre*.

In the case of *P. limbatum*, which Stephani places in his section "*a*" (see p. 274), although he had not himself examined carpocephala, a portion of the original material, likewise in the Mitten herbarium, was examined. Here again nothing was found to warrant a separation from *P. rupestre*. The distinguishing characters, according to Stephani's account, are the following: the pronounced thickenings in the radial walls of the cells bounding

the pores, the appendages of the ventral scales, often double, long-acuminate from a broad base, papulose on the margin. The papulose margin is unfortunately no more pronounced than it sometimes is in specimens of *P. rupestre* from other localities, and the other differences, even if they were constant, would not be of much significance (see FIG. 2, M, N).

The characteristics of *P. elongatum*, according to Stephani, are the following: the monoicous (paroicous) inflorescence, the very minute pores with only two or three cells around the opening, the trigones in the epidermal cells, the semilunate scales abruptly contracted into one or, rarely, two long, narrowly lanceolate and attenuate appendages, and the shortly emarginate carpocephala bearded below by lanceolate or filiform scales. A study of the type-specimen, however, shows that the pores are almost invariably surrounded by four cells (FIG. 1, H), and although the appendages for the most part agree with the description (FIG. 3, R), some of them are subulate rather than lanceolate, the contraction is more gradual than is implied, and even the narrowest appendages are occasionally duplicated in European material of *P. rupestre*. The other characters, even if constant, would scarcely be differential.

In proposing *Aytonia Evansii* as a new species Miss Haynes compared it with *P. elongatum* and naturally laid a good deal of emphasis on Stephani's description. She points out differences between the two species in size, in the structure of the epidermal pores, and in the form of the ventral scales. She separates her species because the pores are bounded by four or five cells instead of by two or three, and because the scales taper gradually instead of abruptly into the appendages. It has just been shown that the characters upon which she relied are subject to considerable variation in *P. elongatum* and that this species cannot be kept apart from *P. rupestre*. It therefore becomes necessary to reduce *Aytonia Evansii* to a synonym of the same species. At the same time it is a pleasure to recommend the careful and accurate description and figures in Miss Haynes's paper to students of the Hepaticae.

In *P. mexicanum* the original authors apparently had only slight confidence. They say that it is closely allied to *P. rupestre*

but that it differs in the more crispate margin of the thallus, in the fact that it is wholly convolute when dry, and in its less conspicuous median canal when moist. They likewise quote a specimen collected by Ecklon and Pappe at the Cape of Good Hope, and although they doubtfully refer this specimen to *P. rupestre*, Lindenberg expresses the opinion that it may be *P. mexicanum*. Stephani adds no differential characters of importance, stating merely that the epidermal cells are surrounded by five or six cells with strongly thickened radial walls, that the epidermal cells have trigones, that the ventral scales have a single appendage, narrowly lanceolate and long-attenuate, and that the carpocephalum is excised at the apex with obtuse, recurved-connivent horns. A portion of the type specimen from the Gottsche herbarium showed most of these characters, although some of the epidermal pores were bounded by only four cells (FIG. 1, E). The specimen showed nothing, however, to justify the maintenance of *P. mexicanum* as a valid species.

Of *P. lanigerum* authentic material was distributed in Spruce's Hepaticae Spruceanae. In the original description the ventral scales were said to be obliquely triangular and acuminate and the elaters to have four spirals. Stephani adds an account of the epidermal cells, which are said to have trigones, and of the pores, which are said to be surrounded by five cells. He states further that the single appendage of the scales is as long as the basal part, lanceolate in form, and acute, and that the elaters have from two to four spirals. It will be seen at once that there is nothing in either description which would not apply to the variable *P. rupestre*, and Spruce's specimens amply support this position.

In addition to the four species just discussed there are several others recognized by Stephani which are evidently very closely related to *P. rupestre*. Among these are the following: *P. dschallanum*, *P. tenue*, *P. algericum*, *P. nepalense*, *P. chlorocarpum*, *P. validum*, *P. caerulescens*, *P. brasiliense*, *P. peruvianum*, and *P. subplanum*. It is probable that some of these will prove to be synonymous with *P. rupestre*, but unfortunately authentic material has not been available for study. A possible exception may be made in the case of *P. tenue*, which Stephani quotes from three South African regions: the Transvaal, *MacLea, Wilms;*

Usambara, *Holst;* and Angola, *Welwitsch.* In the Underwood herbarium there is a specimen from A. Rehmann's Hepaticae austro-africanae, No. 32, collected by MacLea at Müller's Farm in the Transvaal and labeled "*Plagiochasma muricata* Steph." This species was never published but the specimen probably represents *P. tenue*, because no other species of MacLea's Transvaal collection is quoted. Since MacLea's specimen is cited first by Stephani it is even probable that the plant in the Underwood herbarium is part of the type material. The distinguishing characters of *P. tenue* are said to be the following: the dioicous inflorescence (androecia unknown), the very minute epidermal pores surrounded by four cells, the triangular ventral scales bifid two-thirds with parallel, contiguous, narrowly triangular divisions (the latter of course being really the appendages), and the strongly convex carpocephala. MacLea's specimen shows most of these characters except that the carpocephala are distinctly concave. The other characters, moreover, are subject to variation, the pores being sometimes surrounded by five cells and the ventral scales sometimes having a single appendage and sometimes two more or less divergent appendages. In other words the specimen agrees in all essential respects with *P. rupestre.* Whether the other specimens quoted by Stephani represent *P. rupestre* cannot of course be decided, but the probability is that they do.

If *P. rupestre* is accepted in the broad sense of the present paper its geographical distribution becomes very extensive. It is not, however, unique in this respect among the Marchantiaceae. Both *Targionia hypophylla* and *Reboulia hemisphaerica* have a similar and even wider range. Probably if *P. rupestre* extended as far north in Europe as these other two species, it would long ago have been thoroughly known to European writers, and the confusion regarding its synonymy would already have been dispelled.

2. PLAGIOCHASMA CRENULATUM Gottsche

Plagiochasma crenulatum Gottsche, Mex. Leverm. 266. 1863.
Aytonia crenulata Underw. Bot. Gaz. **20**: 66. 1895.

Thallus pale green above but not glaucous, with a narrow purple border, plane or broadly canaliculate, strap-shaped, sparingly forking, sometimes with adventive branches, rarely (if ever) innovat-

ing at the apex, margins undulate-crenate, more or less crispate, mostly 1–3 cm. long and 5–10 mm. broad, thickness of thallus about one sixth the width; epidermis composed of thin-walled cells with distinct trigones and a thin smooth cuticle, the cells about 30 μ in diameter; pores slightly elevated, rather small, surrounded by about six (four to seven) radiating series of cells with two or three cells in each series, radial walls slightly thickened; aeriferous layer about three fourths the thickness of the thallus in the median portion, fairly compact with the air spaces about as wide as the green cells or even narrower close to the epidermis; ventral scales lunulate or ovate, purple, slightly overlapping, irregularly sinuous-dentate along the margin with contorted cells, bearing evanescent slime-papillae, cells containing oil-bodies few and scattered, the scales abruptly contracted into one or (more rarely) two large, broadly ovate appendages, short-apiculate or abruptly acute at the apex, irregularly sinuate-dentate along the margin or bearing one or several sharp teeth or even one or two sharp basal lobes: inflorescence monoicous (autoicous): ♂ inflorescence borne on a short ventral branch: ♀ receptacles borne singly or in tandem pairs; peduncle mostly 1–1.5 cm. long; carpocephalum concave at the apex, or obtusely indented, and two- or three-lobed with apiculate lobes, maturing two or three sporophytes; scales of carpocephalum lanceolate to narrowly ovate, irregularly sinuate on the margin or with an occasional tooth: spores about 80 μ in diameter, yellowish brown, minutely verruculose, regularly reticulate, spherical face usually with eighteen to twenty meshes (ten to twelve marginal), plane faces with about seven (five to eight) meshes, those near apex of pyramid less distinct; elaters gradually attenuate, mostly 270–325 μ long and 12 μ wide in maximum diameter, spirals usually three, often coalescing along a longitudinal line. [FIG. 5.]

The following specimens have been examined:

CHIAPAS: San Cristobal, altitude 2,100 m., November, 1907, *G. Münch 5607* (distributed by Levier).

SONORA: Huchuerache, December, 1890, *C. V. Hartman 307* (Lumholtz Expedition).

VERA CRUZ: Orizaba, *F. Müller* (type); February, 1885, *W. G. Farlow;* January, 1892, *J. G. Smith;* December, 1900, *Conzatti & Gonzales;* November, 1908, *Barnes & Land 685;* on wet ground, Cordova, February, 1885, *W. G. Farlow;* on wall along roadside, Cordova, February, 1907, *Miss L. MacIntyre;* along sides of Metlac Gorge, October, 1908, *Barnes & Land 640, 659.*

Gottsche likewise reports the species from Chinantla, PUEBLA, *F. Liebmann.* No other localities are at present known.

Stephani's treatment of this large and distinct species is difficult to understand. He states that the thallus always innovates at the apex, thus implying that dichotomy never occurs, and he adds among other details that the epidermal pores are large and surrounded by eight or nine radiating series of cells with four cells in each series, that the appendages of the ventral scales are ovate-oblong or broadly linear with shortly acuminate apices, and that the apex of the carpocephalum is plano-convex. It would almost seem as if he had not seen the true *P. crenulatum* at all but had drawn his description from some other species. Gottsche's original account is much more accurate, and Leitgeb (**16**, p. 64, *pl. 1, f. 6*) has given an excellent description, with a figure, of the epidermal pores. He calls attention to the fact that the concentric rings of cells surrounding the pore appear as if partially shoved under one another. The pore-opening thus acquires the form of a canal, although the cells all belong to the same epidermal cell-layer. In the material studied by the writer the pores are surrounded by from four to seven radiating series of cells, six being the usual number (FIG. 5, A), and each series is composed of two or three cells. The radial walls are thickened but not very strikingly so. The circular ridge immediately surrounding the opening is distinct in *P. crenulatum* and in all the following species.

The ventral scales develop large and characteristic appendages, usually singly but occasionally in pairs (FIG. 5, C, D). The scales themselves, as in the other members of the genus, are lunulate or ovate in form and overlap slightly. Their cells diminish in size toward the margin and become exceedingly irregular in form and in the direction of their long axes. Some of the marginal cells project and bear vestiges of slime papillae. The appendages are strongly contracted at their junction with the scales and vary considerably in size. Their form, in general, is broadly ovate to orbicular and they narrow abruptly into an apiculate or shortly acute apex, which is tipped with a single cell or with a row of two or three cells. The cell-structure is very similar to that in the scale itself and the border, composed of irregular and contorted cells, is very different from what is found in the narrower scale-appendages of *P. rupestre*, where the cell-structure of the appendages is practically uniform throughout.

A species closely allied to *P. crenulatum* is the East Indian *P. appendiculatum* Lehm. & Lindenb., one of the two species upon which the genus *Plagiochasma* was based. This interesting plant is known to the writer from a series of specimens, including a part

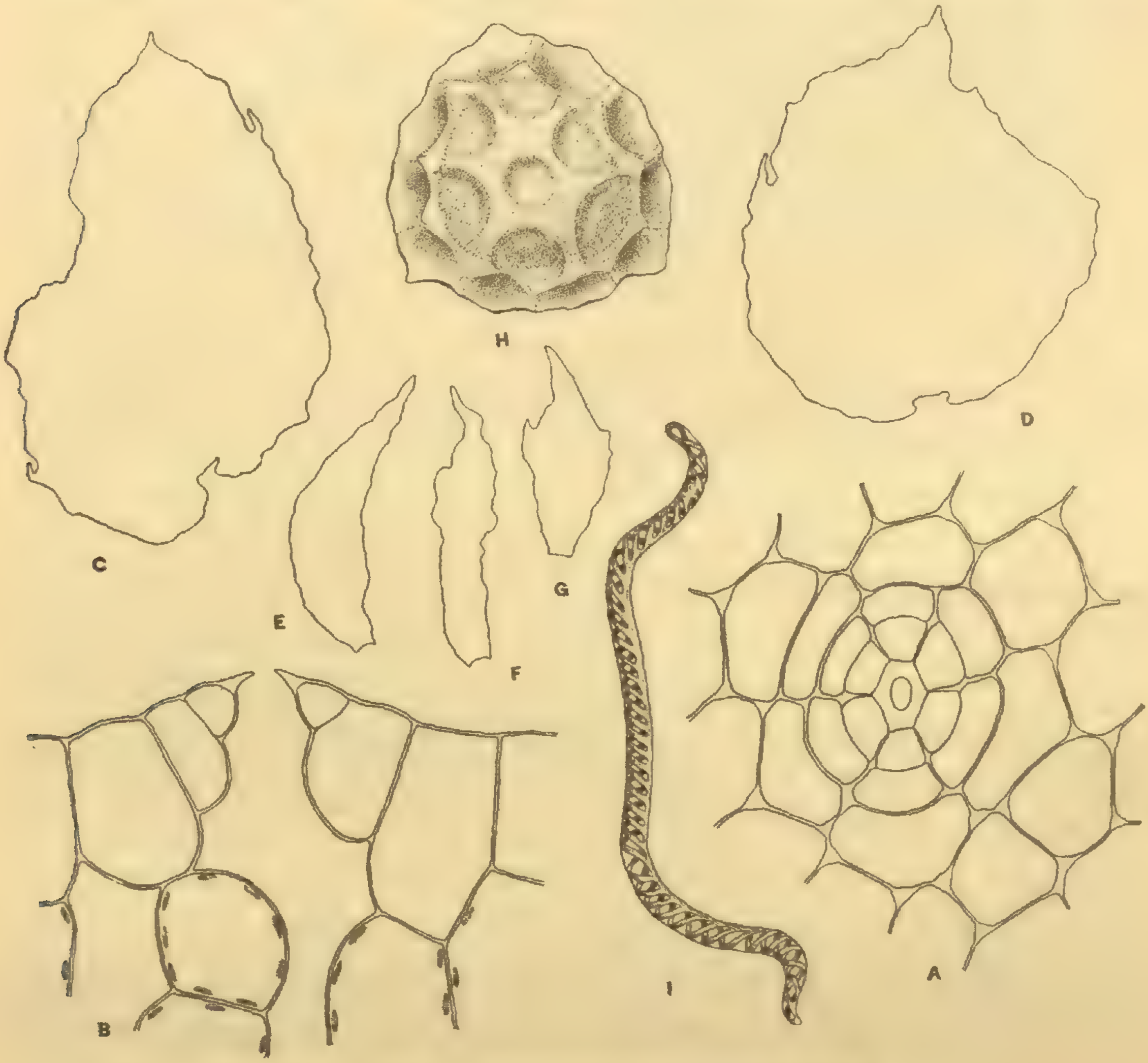

FIG. 5. PLAGIOCHASMA CRENULATUM Gottsche

A. Epidermal pore, surface view, × 300. B. Epidermal pore, cross section, × 300. C, D. Appendages of ventral scales, × 40. E–G. Scales from a carpocephalum, × 40. H. Spore, spherical face, × 225. I. Elater, × 225. The figures were all drawn from specimens collected by Barnes & Land at Orizaba (*685*).

of Wallich's original collection in the Mitten herbarium. It is characterized, as Stephani notes, by the large appendages of the ventral scales, cordate or broadly ovate in form, entire, obtuse, and strongly contracted at the base. This description brings out their peculiarities clearly. It may be added that the cell-structure of the appendages is fairly uniform except for a very narrow border, where the cells are somewhat irregular and contorted.

The epidermal cells and pores are much the same as in *P. crenulatum*, although the number of radiating series of cells around a pore is sometimes as high as eight. The spores are distinctly smaller measuring 50–70 μ in diameter (51 μ according to Stephani), but they are reticulate in much the same way, and the elaters usually show more or less coalescence of their spiral bands.

The specimens collected by Hartman in the state of Sonora come particularly close to *P. appendiculatum*, and their reference to *P. crenulatum* must be considered provisional. The appendages of the ventral scales are distinctly orbicular in most cases with rounded apices and entire margins, so that they simulate those of the East Indian species very closely. If it were not for the occasional presence of appendages distinctly narrowed toward the apex or even acute it would be quite justifiable to consider the Sonora plant distinct from *P. crenulatum*. Unfortunately the material is both scanty and sterile, and the appendages are often so thoroughly bleached that their true structure cannot be well made out. It is possible, therefore, that more complete or fertile material would show that the striking peculiarities of the plants were of an accidental character, and for this reason they are included under *P. crenulatum*.

Another specimen which requires a few words of comment is the one collected by Münch at San Cristobal. This specimen was distributed by E. Levier in his Bryotheca under a manuscript name of Stephani. The writer finds no sufficient grounds, however, for separating it from *P. crenulatum* although the appendages of the ventral scales are somewhat smaller and narrower than in typical forms of the species and taper more gradually toward the apex. Combined with this slight difference the epidermal pores exhibit thicker radial walls than is usual and tend to show more than six radiating series of cells around the opening. In other respects the specimen is like *P. crenulatum*.

3. **Plagiochasma jamaicense** (Haynes) comb. nov.

Aytonia jamaicensis Haynes, Bull. Torrey Club **34**: 58. *pl. 6.* 1907.

Thallus pale green above but not glaucous, with a reddish purple border, plane or broadly canaliculate, strap-shaped, some-

times with adventive branches, sometimes innovating at the apex, rarely (if ever) dichotomous, margins crenulate, more or less crispate, mostly about 1 cm. long and 5–7 mm. wide, thickness of thallus about one eighth the width; epidermis composed of thin-walled cells with small but distinct trigones and a smooth cuticle, the cells about 30 μ in diameter; pores slightly elevated, rather large, surrounded by about eight (five to ten) radiating series of cells with two to four cells in each series, radial walls slightly thickened; aeriferous layer about three-fourths the thickness of the thallus in the median region, fairly compact, with the air-spaces a little wider than the green cells; ventral scales lunulate to ovate, purple, slightly overlapping, irregularly sinuate along the margin with vestiges of slime papillae, cells containing oil-bodies very few and scattered, the scales abruptly contracted into one or (rarely) two ovate appendages, constricted and plicate at the base, entire or vaguely and irregularly dentate or crenate along the margin, often showing vestiges of slime papillae, gradually narrowed toward the apex into an apiculum usually two to three cells long; inflorescence monoicous: ♂ inflorescence (in the few observed cases) near the apex of a thallus, the ♀ receptacles being borne (usually in a series) on the following joint or apical innovation; peduncle of carpocephalum 1–1.5 cm. long; carpocephalum mostly plano-concave at the apex and bluntly two- to four-lobed, usually maturing two sporophytes; scales of carpocephalum lanceolate to linear-lanceolate, acuminate, entire or sparingly and irregularly dentate: spores 70–85 μ in diameter, yellowish brown, minutely verruculose, reticulate but with the meshes often indistinct, spherical face with about twelve meshes (eight or nine marginal), plane faces with about four meshes; elaters gradually attenuate, mostly 250–375 μ long and 8 μ in maximum diameter, with two or three spirals, sometimes slightly coalescent.

The following specimens have been examined:

JAMAICA: Chestervale, Blue Mountains, altitude 900 m., February, 1903, *L. M. Underwood 1173* (type), *1177* (both mixed with *Reboulia hemisphaerica* [L.] Raddi).

No other localities for the species are known.

The above description is largely compiled from the original paper of Miss Haynes, only a few details having been added. The specimens studied bear a very strong resemblance to the *Reboulia* with which they are growing, the size, general habit, and pigmented margin being almost exactly the same. The color, however, is a trifle redder in the *Plagiochasma* and of course the dorsal position of the carpocephala will at once separate it from the *Reboulia*, where the

carpocephala are terminal. The appendages of the ventral scales are likewise very different, those of the *Reboulia* being narrowly linear or lanceolate.

A close relative of *P. jamaicense* is *P. crenulatum*, a somewhat larger and firmer species, the aeriferous layer being a little more compact. In distinguishing the species the best differential characters are drawn from the epidermal pores and ventral scales. Although the pores in the two plants are built up on the same plan, those of *P. jamaicense* tend to be more complex and usually show a greater number of radiating series of cells around the opening with more cells in each series. The ventral scales are much the same in their basal portions except that those of *P. crenulatum* are larger and show a broader border of contorted cells. It is in their appendages that the scales are most distinct. In *P. crenulatum* these are broadly ovate to orbicular, the largest reaching a length of 1–1.4 mm. and a width of about 1 mm.; in *P. jamaicense* they are more narrowly ovate, the largest reaching a length of 0.45 mm. and a width of 0.3 mm. In *P. crenulatum* the apical contraction is usually abrupt, in *P. jamaicense* it is more gradual, and the apex seems to be invariably tipped with a row of two or three cells. Another difference to be noted is in the position of the androecium. In *P. crenulatum* it is borne on a short ventral branch and is apparently never succeeded by female receptacles as is the case in *P. jamaicense*. Unfortunately, as already pointed out, it is unwise to place too much confidence in a difference of this sort. The spores of *P. crenulatum*, finally, are more finely reticulated than in *P. jamaicense*, the spherical face showing eighteen to twenty meshes instead of only twelve.

4. PLAGIOCHASMA WRIGHTII Sulliv.

Plagiochasma Wrightii Sulliv.; A. Gray, Manual, Ed. 2, 688. *pl. 6.* 1856.

Aitonia Wrightii Underw. Bull. Illinois State Lab. Nat. Hist. **2**: 43. 1884.

Thallus pale green and glaucous above, with a narrow purple border, plane or broadly canaliculate, strap-shaped, sometimes forking, sometimes innovating at the apex, sometimes with ventral adventive branches, margins undulate-crenate, more or less crispate, mostly 1.5–2 cm. long and 3–5 mm. broad, thickness of

thallus about one fourth the width; epidermis composed of thin-walled cells with distinct trigones often having bulging sides and a thin cuticle with a waxy covering, the cells averaging about 22 μ in diameter; pores slightly elevated, rather small, surrounded by about six (five to eight) radiating series of cells with two or three cells in each series, radial walls distinctly (and sometimes strongly) thickened; aeriferous layer about three fourths the thickness of the thallus, of a rather loose structure, the air spaces about twice as wide as the green cells; ventral scales lunulate, purple, slightly overlapping, irregularly sinuous-dentate along the margin with somewhat contorted cells, bearing evanescent slime-papillae, cells containing oil bodies few and scattered, the scales abruptly contracted into one or two ovate-lanceolate appendages, obtuse to acute at the apex, entire, more or less constricted and plicate at the base: inflorescence monoicous (autoicous): ♂ inflorescence borne behind the ♀ receptacle or on a short ventral branch: ♀ receptacles borne singly or in a median row of two or three; peduncle mostly 1.5–2 mm. long (3–4 mm. long, according to Stephani); carpocephalum narrowly concave at the apex, two- or three-lobed with apiculate lobes, maturing two or three sporophytes; scales of carpocephalum linear-lanceolate, acuminate, entire; spores brownish yellow, 75–85 μ in diameter, minutely rugulose, regularly reticulate, spherical face usually with twelve or thirteen meshes, plane faces each with four meshes, reticulum often incomplete; elaters gradually attenuate, mostly 225–250 μ in length and 7–9 μ in maximum diameter, spirals two or three, often somewhat coalescent. [FIG. 6.]

The following specimens have been examined:

TEXAS: under overhanging rocks along steams, San Marco, 1848, *C. Wright 9* (type).

ARIZONA: Nogales, February, 1902, *D. T. MacDougal.*

COAHUILA: San Lorenzo Canyon, about 3.5 km. southeast of Saltillo, September, 1904, *E. Palmer 423*.

DURANGO: near the city of Durango, 1896, *E. Palmer 862.*

VERA CRUZ: Cordova, without date, *C. Sallé;* Orizaba, February, 1885, *W. G. Farlow 17* (in Farlow herbarium).

No other localities have been reported.

In studying the present species the writer has had the privilege of examining a portion of the type material. Although carpocephala and sporophytes are present, the spores and elaters are poorly or abnormally developed so that it is impossible to gain from them an accurate idea of the typical structure of these organs.

This is fortunately supplied by the specimens collected by Sallé at Cordova.* The specimens from Arizona and the other Mexican specimens listed above lack carpocephala but show clearly the vegetative characters of the species.

Sullivant's original account, which is reproduced with but slight alterations by Underwood, describes the more striking characters of the plant but does not call attention to the structure of the epidermis and of the ventral scales. These deficiencies are partly supplied by Stephani, who states that the epidermal pores are slightly convex and surrounded by two to three concentric series of cells with six cells in each series and that the appendages of the scales are constricted at the base, ovate, acute, and entire. In her discussion of *Aytonia jamaicensis*, Miss Haynes notes that the concentric series of cells around the pores of *P. Wrightii* are composed of from five to eight cells each, instead of being uniformly composed of six cells, as Stephani's description states.

The epidermal pores in *P. Wrightii* agree in all essential respects with those of *P. crenulatum*, except that the radial walls tend to be more distinctly thickened. The epidermis is further distinguished by its somewhat smaller cells and better developed trigones and by the presence of a waxy cuticular covering, these features being apparently associated with a more xerophytic habitat.

Although Stephani's description implies that the ventral scales bear a single appendage it is not unusual to have two such appendages present. They are characterized by their ovate-lanceolate form and acute or obtuse apices, the margins being usually entire and the cell structure fairly uniform. The appendages are somewhat constricted at the base, but the constriction often appears more marked than it really is on account of the folds in the basal portion. The marginal cells of the basal portion (FIG. 6, D) are more or less irregular and contorted and show vestiges of slime-papillae.

As pointed out by Miss Haynes, *P. Wrightii* is related to *P. jamaicense*. She finds differences, however, in the epidermal

* It may be noted that Berkeley in his Introduction to Cryptogamic Botany (p. 443, *f. 93 a–c*), published in 1857, has figured a carpocephalum and a spore from Sallé's material, under the name *P. mexicanum*.

pores, in the ventral scales, in the length of the peduncle, in the scales of the carpocephalum, and in the spores. Those drawn from the length of the peduncle, from the scales of the carpocephalum and from the spores are perhaps a little untrustworthy and difficult to apply, but the others will serve to distinguish the two species. In *P. Wrightii* the pores are much the same as in *P. crenulatum*, although perhaps a little less elevated; the opening is usually surrounded by six radiating series of cells with two or three cells in each series. In *P. jamaicense* there is a tendency at least toward a greater complexity, many of the pores showing eight radiating series of cells with three or four cells in each series. Of course here, as in so many other cases, it is unsafe to base conclusions on the study of only a few pores, because those of *P. Wrightii* sometimes show as many as eight radiating rows while those of *P. jamaicense* may show as few as six or even five. In most cases the radial wall-thickenings and the trigones are better developed in *P. Wrightii* than in *P. jamaicense.* According to Miss Haynes the appendages in *P. Wrightii* are less constricted and narrower than in *P. jamaicense* with their margins always entire. A study of a considerable amount of material shows that these differences are usually, but not always, present; there are rare cases, for example, where the appendages in *P. Wrightii* are broad enough to be called ovate, where the basal constriction is marked, and

FIG. 6. PLAGIOCHASMA WRIGHTII Sulliv.

A. Epidermal pore; surface view, × 300. B. Ventral scale with two appendages, × 40. C. Appendage from another ventral scale, × 40. D. Cells from the margin of a ventral scale, basal portion, × 225. The figures were all drawn from the specimenscollected in the state of Coahuila, *E. Palmer 423.*

where the margin is vaguely denticulate. These broad appendages, however, seem to be always associated with narrower appendages of the usual type and the apices show a much greater degree of variation than in *P. jamaicense*, being sometimes acute and sometimes obtuse.

Although *P. Wrightii* is doubtless a close relative of *P. crenulatum* the two species differ strikingly in appearance. *P. crenulatum* is not only a larger plant but it looks much firmer and more compact owing to the smaller intercellular spaces in the aeriferous layer. It also lacks the waxy covering on the cuticle, which is sometimes conspicuous in *P. Wrightii* and gives the thallus a glaucous aspect. The margin is about as crenulate in *P. Wrightii* as in *P. crenulatum* but the whole marginal region is thinner and more markedly crispate. With respect to branching, *P. crenulatum* rarely, if ever, develops a jointed thallus, while such a condition is usual in *P. Wrightii*. This difference, however, as already emphasized, is one which must be used with caution.

5. **Plagiochasma Landii** sp. nov.

Thallus pale green above but not glaucous, with a narrow purple border, plane or broadly canaliculate, strap-shaped, rarely forking, usually innovating at the apex or with ventral branches. margins undulate, slightly crispate, 1 cm. or less in length, 4–7 mm. in width, thickness of thallus about one sixth the width; epidermis composed of thin-walled cells with small but distinct trigones and a thin smooth cuticle, the cells averaging about 28 μ in diameter; pores slightly elevated, rather small, surrounded by five to seven radiating series of cells with two or three cells in each series, radial walls slightly thickened; aeriferous layer about three fourths the thickness of the thallus in the middle, fairly compact with the air spaces about as wide as the green cells or a little wider, tending to extend at right angles to the epidermis; ventral scales broadly lunulate, purple, entire, cells along the margin smaller, more or less elongated parallel with the margin and with scattered evanescent papillae, cells containing oil-bodies few and scattered, the scales gradually narrowed into a single subulate, acuminate appendage, varying greatly in length, entire or rarely with a sharp tooth, scales sometimes with two such appendages: inflorescence monoicous (paroicous): ♀ receptacles usually borne singly, peduncles very short, usually about 1 mm. long, scales of the carpocephalum lanceolate, acuminate, somewhat contracted at the

base, variable in size, the largest about 1.2 × 0.3 mm., about ten cells wide, entire or sometimes with one or two short and irregular teeth, oil-containing cells few and scattered; carpocephalum concave at the apex, usually with two short-apiculate and sometimes connivent lobes and maturing two sporophytes: spores yellowish brown, mostly 70–80 μ in diameter, minutely verruculose, regularly areolate, the spherical face mostly with twelve to fifteen meshes (nine to twelve marginal), plane faces each with four (or five) meshes; elaters about 225 μ long and 12 μ in maximum diameter, usually with two distinct spirals, rarely with three. [FIG. 7.]

The following specimens have been examined:

MORELOS: near Cuernavaca, October, 1908, *Barnes & Land 466;* same locality and date, *C. G. Pringle 10669* (distributed in Plant. Mex. as *P. elongatum*). No. 466 may be designated the type.

A remarkable specimen collected by W. G. Farlow at Orizaba, state of Vera Cruz, and preserved in the Underwood Herbarium, should be noted in this connection. It bears the number 17 and is referred to *P. crenulatum* (see Underwood, Bot. Gaz. **20**: 66. 1895). The long and slender appendages of the ventral scales, however, with acuminate apices, would at once exclude it from *P. crenulatum* and indicate an affinity with *P. Landii*. Possibly it should be referred to this species, but the epidermal pores are not quite characteristic, and it is impossible to decide from the material examined whether the slight differences which the pores show come within the range of variation to be expected. Apparently No. 17 was made up of more than one species; as already noted the specimen in the Farlow herbarium preserved under this number is *P. Wrightii*.

In *P. Landii* the group of species to which *P. crenulatum*, *P. jamaicense* and *P. Wrightii* belong has another member, the relationship being perhaps closest to *P. Wrightii*. In size and texture the species approaches *P. crenulatum* but it differs in habit on account of the many apical joints or innovations which it produces. Compared with *P. Wrightii* the thallus is a trifle larger and firmer.

Here again the epidermal pores and the ventral scales yield some of the most trustworthy differential characters. The epidermal pores tend to be somewhat less complex than in the other members of the group, each radiating series bounding the opening

being often composed of only two cells. In this respect it of course recedes most widely from *P. jamaicense*. The cells forming the pore show in a marked degree the peculiarity described by Leitgeb in the case of *P. crenulatum*. They appear as if shoved under one another, and this condition is often so marked that the

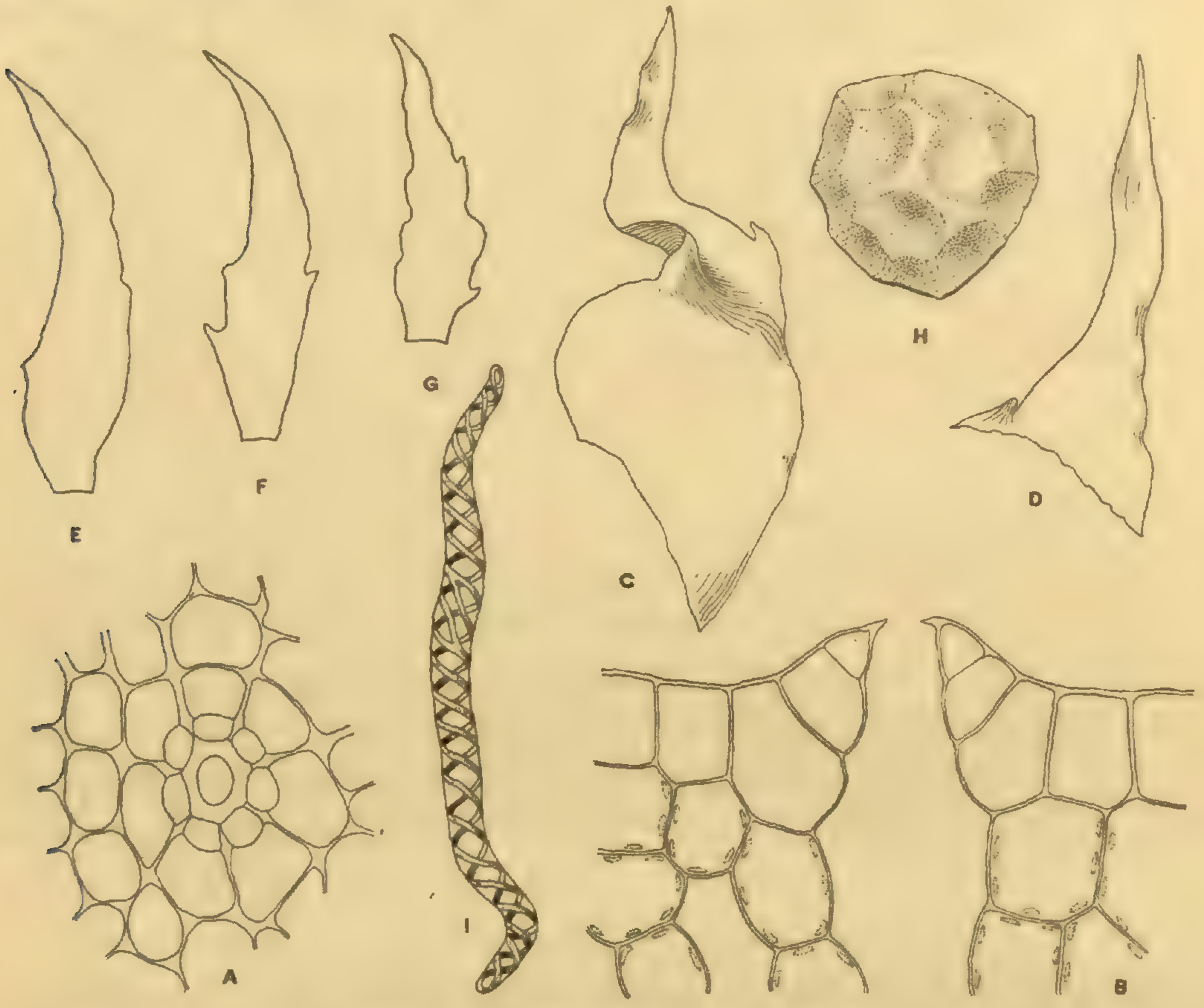

FIG. 7. PLAGIOCHASMA LANDII Evans

A. Epidermal pore, surface view, × 300. B. Epidermal pore, cross-section, × 300. C. Ventral scale with appendage, × 40. D. Appendage of another ventral scale, × 40. E–G. Scales from a carpocephalum, × 40. H. Spore, spherical face, × 225. I. Elater, × 225. The figures were all drawn from the type specimen.

second and third cells in each radiating series lie almost directly under the cell next the opening. The cells in each series are separated by very thin walls, and the lines of junction between these walls and the cuticle are more or less convex when seen from above, thus giving the pore a somewhat distinctive, flower-like appearance.

The ventral scales resemble those of *P. rupestre*, although the basal portion shows a very narrow border of contorted cells and

often bears vestiges of slime-papillae. The basal portion is unusually deeply pigmented, and the pale scattered cells containing oil-bodies stand in sharp contrast to the others. The appendages of the scales, sometimes borne singly and sometimes in pairs, are narrowly triangular or subulate in outline and gradually taper to acuminate points, although the extreme apex is often tipped with two cells bearing the vestiges of a slime-papilla between them. There is no sharp line of demarcation between the basal portion and the appendages and the latter are not constricted at the base. For the most part the margins are entire but occasionally an indistinct tooth is present. The appendages are very different from the broad and strongly constricted appendages of *P. crenulatum* and *P. jamaicense.* They resemble more closely the narrow appendages exceptionally found in *P. Wrightii.* The latter species, however, is sure to show appendages of the usual type on some or most of the scales.

6. PLAGIOCHASMA INTERMEDIUM Lindenb. & Gottsche

Plagiochasma intermedium Lindenb. & Gottsche; G. L. & N. Syn. Hep. 513. 1846.

Rupinia intermedia Trevis. Mem. R. Ist. Lomb. III. 4: 437. 1877.

Aytonia intermedia Underw. Bot. Gaz. 20: 66. 1895.

Thallus pale green above but not glaucous, with a narrow purple border, plane or broadly canaliculate, strap-shaped, occasionally forking but more usually innovating at the apex, sometimes with ventral adventive branches, margins undulate-crenate, 1 cm. or more long, mostly 3–5 mm. wide, thickness of thallus about one seventh the width; epidermis composed of thin-walled cells with small but usually distinct trigones and a thin, smooth cuticle, the cells averaging about 25 μ in diameter; pores distinctly elevated, large, surrounded by about eight (six to ten) radiating series of cells, with two to four cells in each series, radial walls strongly thickened; aeriferous layer about two thirds the thickness of the thallus, of a loose structure, the air spaces often three or four times as wide as the green cells; ventral scales lunulate, purple, sinuous to crenulate along the margin, some of the marginal cells often contorted, cells containing oil-bodies few and scattered, the scales gradually contracted into two appendages, less often into only one, the appendages slightly or not at all constricted at the base, lanceolate to ovate, entire, usually acute

and tipped with a single cell, mostly seven to ten cells wide: inflorescence monoicous: ♂ inflorescence borne near the apex, sometimes on a ventral branch: ♀ receptacles usually borne singly near the apex of the thallus, but sometimes in a median series of two or more, the stalk mostly only 1–2 mm. long; carpocephalum concave with apiculate lobes, commonly maturing two or three sporophytes; scales of carpocephalum lanceolate, acute to acuminate, entire, or rarely with a tooth; spores mostly 60–70 μ in diameter, minutely verruculose, sometimes reticulated, sometimes not, the spherical face then showing a periclinal ridge and one or two irregular supplementary ridges, and each plane face a periclinal ridge; elaters 200–250 μ long and 9–12 μ in maximum diameter, tapering gradually to blunt extremities, usually with uniformly thickened walls and a very narrow cell cavity, rarely with rudimentary spiral bands. [FIG. 8.]

The following specimens have been examined:

JALISCO: near Guadalajara, 1889, *C. G. Pringle 700* (see Underwood, Bot. Gaz. **20**: 66. 1895); wet banks and rocks, Barranca de Oblatos, Guadalajara, September, 1908, *Barnes & Land 136;* moist rocks, Barranca Ibarra o Portella, below Experiencia, September, 1908, *Barnes & Land 146;* banks of streams, road to San Domingo Mine and adjacent gullies and hills, Etzatlan, October, 1908, *Barnes & Land 261*.

PUEBLA: banks along Avenida Hidalgo and path to Barranca Tezuitlan, October, 1908, *Barnes & Land 538*.

VERA CRUZ: San Antonio Huatusco, mixed with *Targionia hypophylla* L., 1857, *C. Mohr 146*.

GUATEMALA: Guachipilin, Dept. Santa Rosa, September, 1893, *Heyde & Lux;* Cuajiniquilapa, Dept. Santa Rosa, August, 1894, *Heyde & Lux* (see Underwood, Bot. Gaz. **20**: 66. 1895). Both specimens were distributed by John Donnell Smith under No. 6292.

JAPAN: Ogawa-mura, Tosa, July, 1900, *T. Yoshinaga 6*.

The species has likewise been reported from several other localities in Mexico and Japan and from the province of Shen-si in China. TYPE LOCALITY: Hacienda de Jovo, VERA CRUZ, *F. Liebmann*.

The remarkable elaters of *P. intermedium* with their uniformly thickened walls will usually serve to distinguish the species from its American allies, even if thickening of this type is not absolutely constant. In the case of sterile specimens the epidermal pores

and the ventral scales afford differential characters of importance. The pores are much like those of *P. jamaicense* and tend, if anything, to be even more complex, frequently showing nine radiating series of cells around the opening with four cells in each series. The radial walls separating the series are, moreover, strongly thickened. The ventral scales bear considerable resemblance to those of *P. Landii* and *P. Wrightii.* The basal portion shows a vague border of contorted cells, the margin itself being indistinctly

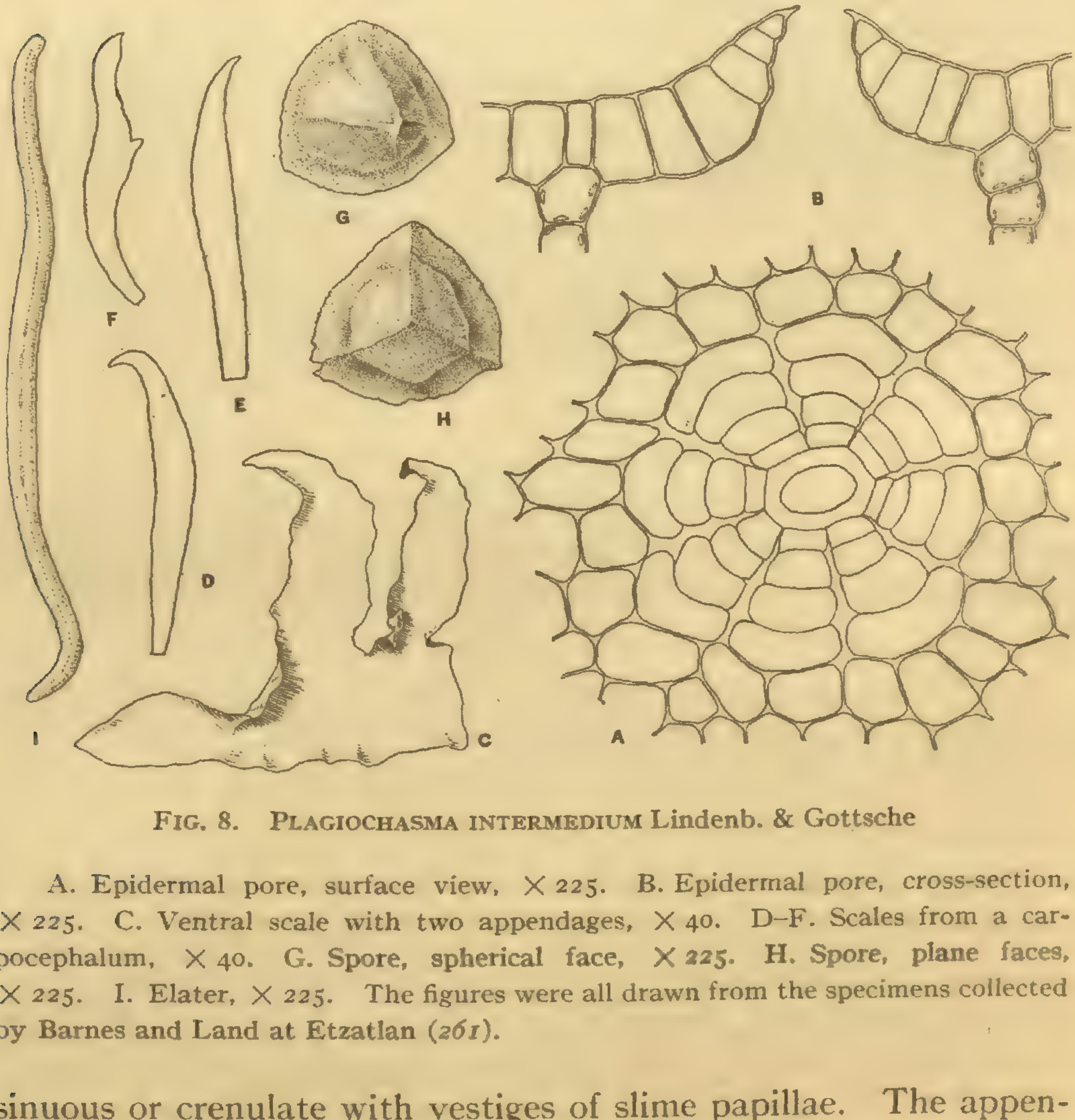

FIG. 8. PLAGIOCHASMA INTERMEDIUM Lindenb. & Gottsche

A. Epidermal pore, surface view, × 225. B. Epidermal pore, cross-section, × 225. C. Ventral scale with two appendages, × 40. D–F. Scales from a carpocephalum, × 40. G. Spore, spherical face, × 225. H. Spore, plane faces, × 225. I. Elater, × 225. The figures were all drawn from the specimens collected by Barnes and Land at Etzatlan (*261*).

sinuous or crenulate with vestiges of slime papillae. The appendages, usually borne in pairs, are lanceolate to ovate and commonly acute. According to Stephani they are strongly constricted at the base, but this condition is apparent rather than actual and seems to be due to the presence of basal folds. When these are not present the appendages show no appearance of constriction.

Although the appendages are much like those of *P. Landii* and *P. Wrightii* they are distinguished from the first by their blunter apices and from the second, usually at least, by their narrower form and lack of basal constrictions.

In proposing *Aitonia japonica* as a new species Stephani emphasized the solid elaters and spoke of them as a unique feature, apparently overlooking the fact that Gottsche had assigned similar elaters to *P. intermedium* many years earlier. In his Species Hepaticarum, however, Stephani recognizes both *P. japonicum* and *P. intermedium* and ascribes solid elaters to both. A comparison of his descriptions brings out the following differences. In *P. japonicum* the thallus is said to be dichotomous and to innovate from the apex and laterally from the midrib; the epidermal cells to have trigones, and the pores to be surrounded by three or four concentric series of cells with six to eight cells in each series; the appendages of the ventral scales to be ovate-oblong or elliptical; the carpocephalum to be plano-convex with rounded lobes; and the spores to be 50 μ in diameter. In *P. intermedium* the thallus is said to be rarely dichotomous but to innovate from the apex; the epidermal cells to have thick walls but no trigones; the pores to be surrounded by three concentric series with eight cells in each series; the appendages of the ventral scales to be strongly constricted, ovate-oblong, acute, and entire; the carpocephalum to be concave, the lobes showing erect-recurved and connivent horns; and the spores to be 60 μ in diameter.

It will at once be seen that most of these differences are slight or relate to characters which may be expected to be variable. Those drawn from the epidermal cells and from the carpocephala seem at first sight to be more important. Unfortunately they prove to be either inconstant or based on hasty observations. The epidermal cells in *P. intermedium*, for example, have distinct trigones even if they are sometimes small; and the carpocephala in Yoshinaga's specimens of *P. japonicum* are distinctly concave at the apex and show apiculate lobes, agreeing with the usual condition in *P. intermedium*. The writer, in fact, has been able to find no valid characters distinguishing the North American from the Asiatic species and therefore feels compelled to reduce the latter to synonymy, in spite of its wide geographical separation.

The spores reproduced (FIG. 8, G, H) were drawn from the specimens collected at Etzatlan, *261*, and show very few ridges except those along the edges of the tetrahedron. These ridges do not form a reticulum. On the spherical face a continuous wavy ridge is present about half way between the periphery and the center, and from one to three additional ridges extend partly or wholly across the enclosed space. On each plane face a single ridge extends across about half way between the base and apex of the triangles. Unfortunately these spore characters, which at first sight appear so striking, are subject to variation. In the spores of the Guadalajara material, *136*, a regular reticulum is present in most cases, and the two extreme types of spore-structure are connected by a series of intergradations. The Japanese specimens of *P. japonicum* show spores with a diameter of about 70 μ and a well-developed reticulum. In Massalongo's figures, drawn from his variety *chinense*, the reticulum is clearly shown but the number of meshes represented is greater than in the Japanese material. In the Synopsis Hepaticarum a specimen from Nepal is doubtfully included under *P. appendiculatum* as "? β *depauperata*." Gottsche states that this plant is close to *P. intermedium* and implies that the elaters are of the solid type, while Massalongo cites it as a possible synonym of *P. japonicum* β *chinense*. Unfortunately the lack of specimens has made the study of this form impossible to the writer. It should be remembered, however, that Kashyap occasionally finds solid elaters in *P. appendiculatum*, so that their presence in this doubtful form would not necessarily exclude it from that species. The Synopsis tells us nothing about the epidermis or ventral scales, and Stephani does not mention the plant at all.

The present paper is based on the study of a large series of specimens, including type material of the following previously published species: *P. appendiculatum*, *P. australe*, *P. cordatum*, *P. crenulatum*, *P. elongatum*, *Aytonia Evansii*, *P. eximium*, *P. jamaicense*, *P. lanigerum*, *P. limbatum*, *Reboulia maderensis*, and *P. mexicanum*. For the privilege of studying this rich material the writer is largely indebted to Dr. M. A. Howe, of the New York Botanical Garden, Dr. W. G. Farlow, of Harvard University,

Dr. G. Lindau, of the University of Berlin, Professor C. R. Barnes and Dr. W. J. G. Land, of the University of Chicago, and Miss Caroline C. Haynes, of New York City. The collection belonging to the New York Botanical Garden, which includes specimens from the Mitten and Underwood herbaria, has proved particularly helpful. A series of unpublished drawings by Miss Haynes has likewise been of much assistance.

SHEFFIELD SCIENTIFIC SCHOOL,
YALE UNIVERSITY

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1913–1915

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Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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POLYGONATUM PUBESCENS (WILLD.) PURSH

A. POLYGONATUM PUBESCENS (WILLD.) PURSH

B. POLYGONATUM PUBESCENS CUNEATUM (GREENE) FARWELL

A. POLYGONATUM BOREALE GREENE

B. POLYGONATUM BOREALE AUSTRALE FARWELL

A. POLYGONATUM BIFLORUM WALT.

B. POLYGONATUM BIFLORUM VIRGINICUM (GREENE) FARWELL

A. POLYGONATUM BIFLORUM OVATUM FARWELL

B. POLYGONATUM ELLIPTICUM FARWELL

A. POLYGONATUM CANALICULATUM (MUHL.) PURSH

B. POLYGONATUM CANALICULATUM AMERICANUM (HOOK.) FARWELL

POLYGONATUM CANALICULATUM GIGANTEUM (DIETR.) FARWELL

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BULLETIN

OF THE

TORREY BOTANICAL CLUB

JUNE, 1915

Some new species and varieties of Bihai*

ROBERT F. GRIGGS

(WITH PLATE 19 AND SIX TEXT FIGURES)

For a number of years the writer has contemplated publishing a revision of the musaceous genus *Bihai*. Inasmuch as this has been much delayed, it has been thought wise not to withhold the publication of the several new species which have come to light in the course of the work. In order to enable the student rightly to place the new species among the old a key to all the species is also given. The preparation of this in turn has involved the revision of the subgenera and minor groups which is herewith presented.

Intrageneric Relationships.—In previous treatments the species have been grouped under two subgenera, which under somewhat varied characterizations included respectively the large species and the small species. The first of these to receive a name, *Taeniostrobus*, was founded by Kuntze on his *B. imbricata*. Baker, however, ignored Kuntze's name and included this species under his own subgenus *Platychlamys*, with *B. Bihai* as type, which was taken as synonymous with *Taeniostrobus* by Schumann and replaced by it. The narrow bracted species were thrown together by Baker under the name *Stenochlamys* (type *B. psittacorum*) and this was adopted by Schumann. While one recognizes a more or less natural subdivision of the genus around these types there are no characters by which it can be so divided without tearing

* Contribution from the Botanical Laboratory of the Ohio State University, No. 89.

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asunder closely related species, such for example as *B. longa*, *B. pendula*, and *B. marginata*, which though very closely related, differ in size and width of the bracts so much that they are necessarily thrown into different subgenera by the key characters. As one goes through the genus he finds so many difficulties of this sort that it becomes clear that some other method of subdivision is necessary. A new classification is therefore proposed which while retaining the old subgenera as recognizable primary subdivisions, even if they are somewhat indefinitely characterized, is mainly built around smaller groups of rather closely similar species. The names of these groups have been taken from the specific names of characteristic species, indicating therefore categories of lower rank than the subgenera with their substantive designations. Before proceeding to the key it may be well to outline this proposed classification.

TAENIOSTROBUS

EPISCOPALES, including only *B. episcopalis*.

IMBRICATAE, including *B. conferta*, *B. Wagneriana*, *B. imbricata*, *B. densa*, *B. reticulata*, *B. punicea*, *B. Mariae*, and *B. curtispatha* (intermediate).

PENDULAE, including *B. rostrata*, *B. longa*, *B. revoluta*, *B. pendula*, *B. Collinsiana*, *B. villosa*, *B. platystachys*, and *B. marginata*.

CHAMPNEIANAE, including *B. Bihai*, *B. Champneiana*, *B. barqueta*, *B. borinquena*, *B. rutila*, *B. purpurea*, *B. stricta*, and *B. humilis*.

STENOCHLAMYS

DISTANTES, including *B. velligera*, *B. metallica*, *B. spissa*, *B. dasyantha*, *B. tortuosa*, *B. geniculata*, *B. librata*, *B. adflexa*, *B. lingulata*, *B. distans*, *B. latispatha*, *B. brasiliensis*, *B. acuminata*, and *B. Burchellii*.

CANNOIDEAE, including *B. glauca*, *B. densiflora*, *B. angusta*, *B. crassa*, *B. aurantiaca*, *B. straminea*, *B. Harrisiana*, *B. hirsuta*, and *B. psittacorum*.

Key to the species of Bihai

1. Branch-bracts closely imbricated forming a compact spike ..... 2.
1. Bracts standing apart, distant or slightly overlapping when in flower ..... 11.
2. Bracts persistent (IMBRICATAE) ..... 3.

2. Bracts deciduous, strictly ascending, scarlet with yellow margins.
B. episcopalis (Vellozo) Kuntze.
3. Inflorescence 25 cm. broad at base....4.
3. Inflorescence about 15 cm. broad....5.
4. Rachis straight, leaves rounded to the base...*B. conferta* (Peters.) Kuntze.
4. Rachis somewhat flexuose, leaves cuneate, very inequilateral.
B. Wagneriana (Peters.) Kuntze.
5. Inflorescence erect or "suberect"....6.
5. Inflorescence pendulous....8.
6. Leaves green, inflorescence peduncled....7.
6. Veins and veinlets conspicuously marked with red, inflorescence sessile, close to the ground, red and yellow....*B. reticulata* Griggs.
7. Inflorescence 15 cm. wide, bracts 10 cm. long....*B. imbricata* Kuntze.
7. Inflorescence scarcely exceeding 10 cm. in width, middle bracts 4–5 cm. long.
B. densa Griggs.
8. Bracts suborbicular, widest at the middle, rose red, plant very large....10.
8. Bracts ovate, widest below the middle, medium sized plants....9.
9. Inflorescence deltoid, somewhat loose, red purple....*B. punicea* Griggs.
9. Inflorescence oblong, dense, scarlet....*B. densa* Griggs.
10. Bracts closely imbricated, concealing the rachis, flowers rose colored where exposed....*B. Mariae* (Hook. f.) Kuntze.
10. Bracts touching only at the middle, not concealing the rachis, flowers yellow.
B. curtispatha (Peters.) Kuntze.
11. Inflorescence pendent (PENDULAE)....12.
11. Inflorescence erect....20.
12. Bracts broad, nearly as wide as long when flattened out....13.
12. Bracts narrow, not more than half as wide as long....15.
13. Bracts rhomboid, widest at the middle, close and slightly imbricated.
B. curtispatha (Peters.) Kuntze.
13. Bracts ovate, widest below the middle, spaced out on the rachis....14.
14. Rachis rather short, bracts rather close, margined with green, suddenly narrowed above the strongly rostrate tip, plant below medium size.
B. rostrata (Ruiz & Pavon) Griggs.
14. Inflorescence very long, bracts remote, scarlet, bright rufous pubescent within, gradually narrowed to the tip, plant very large....*B. longa* Griggs.
15. Bracts scarlet, flowers yellow....16.
15. Bracts variegated, red with yellow edges....18.
16. Bracts only slightly concave, margins revolute....*B. revoluta* Griggs.
16. Bracts boat-shaped, not revolute....17.
17. Peduncle, rachis and bases of bracts ferruginous-pubescent, rachis strongly flexuose, leaves typically green beneath....*B. pendula* (Wawra) Kuntze.
17. Glabrous throughout, rachis nearly straight, leaves heavily glaucous.
B. Collinsiana Griggs.
18. Peduncle and inflorescence densely villous with long bright rufous hair, flowers white....*B. villosa* (Klotzsch) Kuntze.
18. Inflorescence merely puberulent....19.
19. Plant large, rachis nearly straight, middle bracts exceeding 10 cm., flowers reddish.
B. platystachys (Baker) Griggs.
19. Plant of medium size, rachis strongly flexuose, middle bracts less than 10 cm. long.
B. marginata Griggs.

20. Rachis about 2 cm. in diameter, bracts glabrous, thick and fleshy, shriveling much in drying (CHAMPNEIANAE) ..... 21.
20. Rachis seldom exceeding 1 cm. in diameter, bracts mostly chartaceous, shriveling little ..... 30.
21. Inflorescence long-peduncled, scarlet..... *B. Bihai* (L.) Griggs.
21. Inflorescence sessile..... 22.
22. Bracts of one color..... 23.
22. Bracts variegated..... 26.
23. Flower with a subgibbous expansion on the anterior side, filaments strongly bent, petals of nearly the same texture as the sepals..... 25.
23. Flower merely arcuate, petals very delicate, shorter than the sepals..... 24.
24. Inflorescence orange..... *B. Champneiana* Griggs.
24. Inflorescence rose colored..... *B. barqueta* (Loes) Griggs.
25. Inflorescence orange..... *B. borinquena* Griggs.
25. Inflorescence scarlet..... *B. borinquena coccinea* Griggs.
26. Bracts margined with yellow..... 27.
26. Bracts red and green..... 28.
27. Bracts red and yellow, narrowly ovate, about 6 cm. wide, barely touching each other, perianth 5 cm. long, posterior sepal broadly lanceolate..*B. rutila* Griggs.
27. Bracts purple and yellow, 8–10 cm. wide, close together, perianth segments 6 cm. long, linear-oblong..... *B. purpurea* Griggs.
28. Bracts scarlet with green margins, few, plant rather small (2 m.), leaves scarcely exceeding 1 m..... 29.
28. Bracts green with a patch of red on the cheeks, more numerous, plant up to 4 m. tall, leaves elongate, cuneate-oblong..... *B. elongata* Griggs.
29. Bracts very broad, 6 cm. deep, plant about 1.5 m. tall, flowers tipped with white. *B. stricta* (Huber) Griggs.
29. Bracts about 3 cm. deep, larger, flowers colorless below, green where exposed. *B. humilis* (Jacq.) Griggs.

30. Medium sized plants, leaves commonly surpassing 50 cm., habit musoid or submusoid (DISTANTES)..... 31.
30. Small plants, commonly about a meter tall, if taller very slender, leaves about 30 cm. long, habit cannoid (CANNOIDEAE)..... 46.
31. Not villous..... 32.
31. Inflorescence thickly covered with very long hair. *B. velligera* (Poepp.) Kuntze.
32. Leaves green or glaucous, bracts colored..... 33.
32. Leaves purple beneath, bracts green... *B. metallica* (Planch. & Linden) Kuntze
33. Inflorescence persistently hairy..... 34.
33. Inflorescence glabrous unless when young..... 37.
34. Inflorescence long peduncled, bracts more or less twisted out of the distichous arrangement..... 35.
34. Inflorescence sessile, bracts distichous, prevailingly yellow... *B. spissa* Griggs.
35. Bracts solid red..... 36.
35. Bracts green with red cheeks, flowers yellow. *B. dasyantha* (Koch. & Bouché) Kuntze.
36. Bracts ovate-lanceolate, flowers green, only their tips exserted. *B. tortuosa* Griggs.

36. Bracts narrowly lanceolate, flowers yellow, geniculate, standing out of the bracts at anthesis.....*B. geniculata* Griggs.
37. Bracts slightly concave, their edges revolute.....38.
37. Bracts boat-shaped, not revolute.....39.
38. Middle bracts about 15 cm. long, yellow with purple tips.
B. lingulata (Ruiz & Pavon) Griggs.
38. Middle bracts about 7 cm. long, scarlet, inflorescence long peduncled.
B. adflexa Griggs.
39. Perianth 15–20 mm. long, inflorescence deltoid, compact...*B. librata* Griggs.
39. Perianth 30–60 mm. long, inflorescence oblong, rather lax.....40.
40. Inflorescence orange.....41.
40. Inflorescence red.....42.
41. Flowers exserted, rachis very flexuose, bracts, at least the lower, strongly falcate.
B. distans Griggs.
41. Flowers and their bracts entirely included, rachis and bracts nearly straight.
B. latispatha (Benth.) Griggs.
42. Bracts reaching 15 cm. in length.....43.
42. Bracts 5 cm. long, all deflexed, flowers golden yellow.
B. Burchellii (Baker) Griggs.
43. Flowers straight or slightly arcuate, not closely appressed nor suddenly erected .44.
43. Perianth geniculate at anthesis, flowers numerous but opening one or two at a time, appressed to the channel of the bracts until near anthesis, then quickly raised by a bend in the pedicel, bracts scarlet, horizontal, three ranked, of very diverse ages.....*B. geniculata* Griggs.
44. Margins of bracts not involute, flowers reddish (or yellow), habit cannoid.
B. acuminata (Rich.) Kuntze.
44. Margins of the bracts involute, all arcuate ascending, flowers greenish white..45.
45. Leaves green beneath.....*B. brasiliensis* (Hook.) Kuntze.
45. Leaves glaucous.....*B. brasiliensis pulverulenta* (Hook.) Griggs.
46. Bracts as brightly colored as the rachis, leaves green on both sides.....47.
46. Bracts and flowers yellowish green, rachis and pedicels red, leaves glaucous.
B. glauca (Poit.) Kuntze.
47. Bracts exceeding 10 cm. in length.....48.
47. Bracts, unless the lowest, scarcely reaching 10 cm.....50.
48. Bracts spreading at flowering time, not involute, flowers not tipped with black .49.
48. Bracts strictly ascending at flowering time, involute and bayonet pointed, flowers tipped with black.....*B. densiflora* (Verlot) Kuntze.
49. Leaves narrowly oblong, flowers white, pedicels orange.
B. angusta (Vellozo) Griggs.
49. Leaves elliptical, flowers reddish (or yellowish), pedicels red.
B. acuminata (Rich.) Kuntze.
50. Flowers not darkened at the tip, yellow.....51.
50. Flowers maculate.....53.
51. Bracts red.....52.
51. Bracts orange, leaves mostly petioled.....*B. crassa* Griggs.
52. Bracts somewhat ascending, rachis green, leaves about 30 cm. long, sessile, subcordate, peduncle short, flowers pale yellow.
B. aurantiaca (Ghiesb.) Kuntze.
52. Bracts all deflexed, leaves reaching 60 cm., rounded at the base, peduncle elongated, flowers golden yellow..... *B. Burchellii* (Baker) Griggs.

53. Inflorescence brightly colored.....54.
53. Inflorescence greenish yellow, pubescent.....*B. straminea* Griggs.
54. Bracts not particolored.....55.
54. Bracts scarlet above, greenish yellow below.....*B. Harrisiana* Griggs.
55. Bracts scarlet, concave, acute.....56.
55. Bracts orange, revolute and scarcely concave, obtusish.
B. psittacorum (L. f.) Kuntze.
56. Inflorescence pubescent.....***B. hirsuta*** (L. f.) Griggs.
56. Inflorescence glabrous.....*B. hirsuta cannoidea* (Rich.) Griggs.

FIG. 1. *Bihai densa* Griggs; three-eighths natural size.

Bihai densa sp. nov.

Plant of medium size, petiole 70 cm. long, leaf 80 cm. long, 30 cm. wide, acute, subcordate at the base, thin and tough, main veins 5–10 mm. apart, green and glabrous except the midrib and petiole which are pilose with projecting ferruginous hairs about 1 mm. in length; inflorescence erect (?), 18 cm. high, half as wide, oblong, nearly 1 cm. thick (dry), nearly glabrous, peduncle 20 cm. long in the type, somewhat shriveled but 1 cm. thick, rachis nearly straight, concealed, except at the very base, stiff; bracts ascending, fifteen in the type, scarlet, thick and firm, shriveling little, broadly ovate, rostrate, inclined to be involute at the tips, the lowest standing somewhat apart, the rest closely imbricated, middle

bracts 4–5 cm. long, 5–6 cm. wide, widest near the base; flowers about a dozen to a bract, only their tips visible, bracteoles delicate, 30 × 12 mm., flower very small, perianth 20–25 mm., sepals pubescent, thick, indurated at the tips, the posterior 2–3 mm. longer than the other floral parts, petals 3, pedicels finally about 12 mm., berries 9 mm. in diameter (dry) concealed within the bracts. [TEXT FIG. 1.]

PANAMA: around Dos Bocas, Rio Fató Valley, province of Colon, altitude 40–80 m., in dark shady forest, August 16, 1911, *H. Pittier*. Type in National Herbarium, sheet 678445.

Bihai densa is nearest *B. punicea* from which it differs especially in the shape and color of the bracts, and the flower characters. The only one of the previously known species which could be mistaken for either is *B. imbricata*.

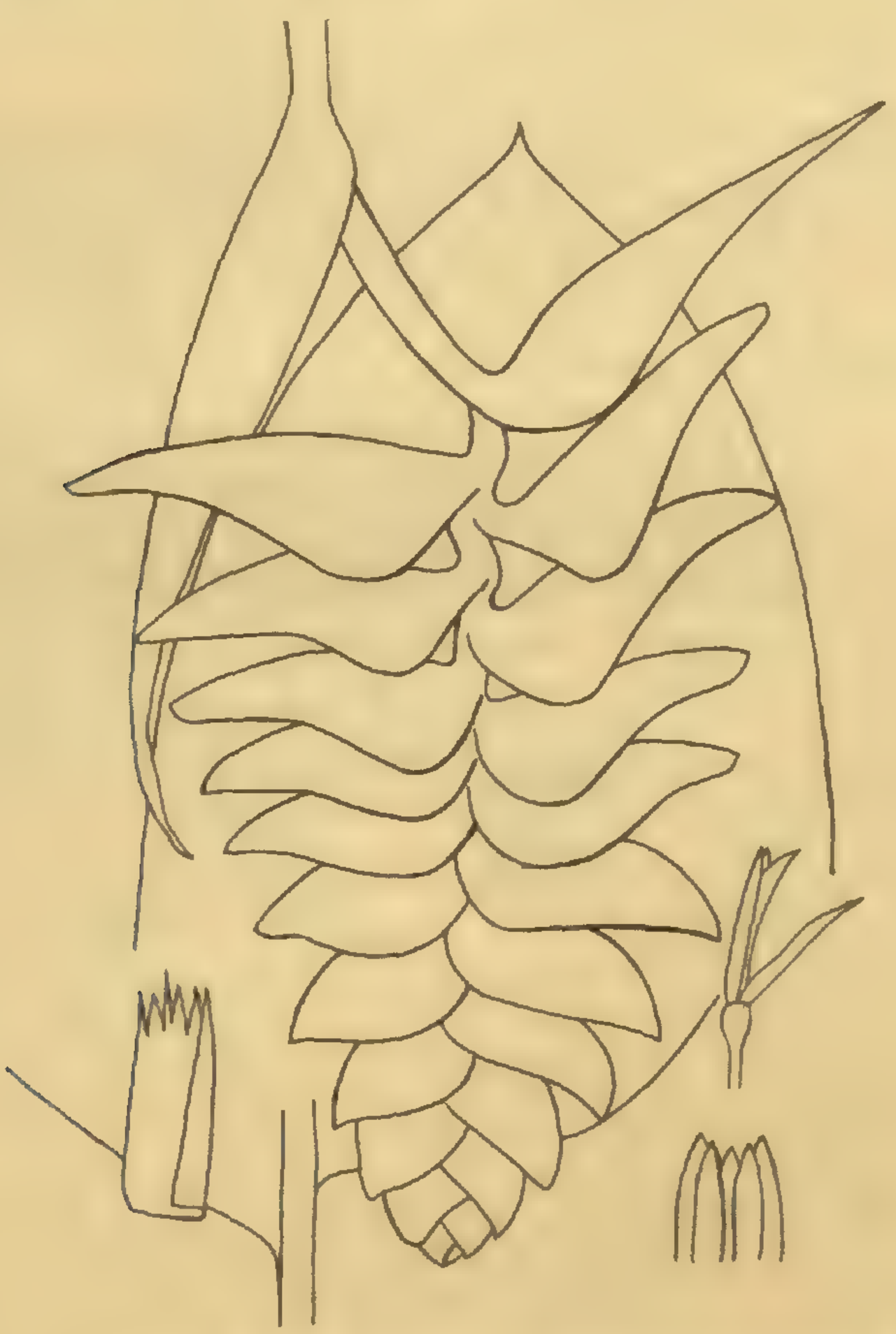

FIG. 2. *Bihai punicea* Griggs; three-eighths natural size.

Bihai punicea sp. nov.

Plant of medium size, leaf about 1 m. long, 25 cm. wide, green and glabrous, acute; inflorescence pendent, deltoid, about 12 cm. wide, a little longer, peduncle 30 cm. long, 7 mm. thick (dry),

glabrous, rachis nearly straight, stiff, glabrescent, concealed above but visible below, bracts twenty-three in the type, mostly horizontal, red-purple, covered with tawny hair, boat-shaped, ovate when opened out, widest near the base, slightly arcuate, very obtuse, except the lower, those from the middle of the inflorescence about 5 cm. long, of the same breadth, the lowest 14 cm., the highest only about 1.5 cm.; flowers a little shorter than the bracts, less numerous than in allied species, bracteoles ample, 40 × 25 mm., obtuse and frayed at the tip, persistent, flowers curved up out of the bracts toward the large sepal, perianth about 3 cm. long, lateral sepals free, corolla limb tridentate, the middle tooth smaller than the other two. [TEXT FIG. 2.]

PANAMA: between Gorgona and Gatun, altitude 10–50 m., Smithsonian Biological Survey, January 7, 1911, *H. Pittier 2290*. In National Herbarium, sheets 677161, 676544, 676545.

Bihai revoluta sp. nov.

Plant of medium size, leaf (known to me only from a sucker) elliptical, 50 × 15 cm., acuminate, rounded to the slightly decurrent base, green and glabrous; inflorescence pendent, red, rachis straight, flexible, internodes mostly about 3 cm. long, covered with abundant evanescent ferruginous tomentum, bracts numerous, horizontally divaricate, more or less tomentose at the base, linear-oblong, obtuse, slightly concave, their margins conspicuously revolute soon after opening, middle ones about 12 cm. long, 2 cm. wide: bracteoles persistent, about 1 × 5 cm., glabrous, flowers rather numerous, pedicel and ovulary red, perianth yellow, glabrous, about 5 cm. long, sepals thick, free, petals two (in the type), shorter by 2–3 mm. and much more delicate than the sepals. [TEXT FIG. 3.]

FIG. 3. *Bihai revoluta* Griggs; about half natural size.

COLOMBIA: Santa Marta, 1898–1901, *H. H. Smith 2315*, with the following field note: "Thickets and forest near streams, 3,500–5,000 feet. Bract and pedicel red, flower yellow. Specimen is from Manzanares, 3,500 feet, March 1." Type in the herbarium

of the New York Botanical Garden; specimens seen also from the Missouri Botanical Garden and from the National Herbarium. The following station may likewise be recorded: Orizaba, MEXICO, *Botteri 523*.

The narrow revolute bracts of this species at once differentiate it from all other known species except *B. lingulata* and *B. adflexa*. There is, however, no close resemblance between the stiff erect inflorescence of *B. adflexa* and the lax panicle of the present species. The resemblance to *B. lingulata* is much closer, but that species has yellow bracts and a compact inflorescence with internodes only one third as long.

FIG. 4. *Bihai marginata* Griggs; about three-sevenths natural size.

Bihai marginata sp. nov.

Plant about 4 m. tall, trunk 6 cm. in diameter at base, petiole 50 cm. long, leaf blade 60 × 15 cm., oblong, acute, rounded at the

base, green and glabrous on both sides; inflorescence pendent, less than 20 cm. long in the type, 10–12 cm. wide, exposed portion of the peduncle less than 10 cm. long, slender, about 5 mm. in diameter, softly puberulent with light brown hair, rachis strongly flexuose in smooth curves, stiff, minutely puberulent, internodes about 25 mm. long, bracts eight in the type, all reflexed, scarlet with yellow margins, somewhat puberulent, shallowly boat-shaped, ovate-lanceolate when flattened out, gradually narrowed to an obtuse tip, those in the middle of the inflorescence 8–9 cm. long, 4 cm. wide; flowers rather numerous, the younger pushing the ripening fruit out beyond the edges of the branch bracts, bracteoles 60 × 15 mm., triangular-lanceolate, very acute, pubescent on the back, persistent in fruit, perianth 5 cm. long, curved toward the larger sepal, lipped, sepals all free, corolla limb three-toothed, middle tooth somewhat smaller than the others, pedicel about 15 mm. long in fruit, berry (apparently ripe) oblong, 15 mm. long, half as wide. [TEXT FIG. 4.]

PANAMA: Marraganti and vicinity, 3–60 m. altitude, April 3–9, 1908, *R. S. Williams 696*. Type in the herbarium of the New York Botanical Garden.

Bihai barqueta (Loes) comb. nov.

Heliconia barqueta Loes, Verh. Bot. Verein. Brandenburg **51**: 18. 1909. "Mexico in prov. Vera Cruz in distr. Jalapa ad fluvii ripam. in coffeeto Sel. n. 3609 Flor. Dec."

Closest to *B. Champneiana* from which it differs in the rose-colored inflorescence whose bracts are more distant than in that species. While this plant would appear to be safely distinct from *B. Champneiana* the relations found to exist between the orange and red bracted forms in Jamaica (see below) makes it desirable to have information concerning the flower characters not furnished by the description since recent studies have shown that these characters have great diagnostic value.

Bihai borinquena coccinea Griggs & Harris, var. nov.

Closely similar to *B. borinquena* in the floral parts but differing in the brilliant scarlet-crimson bracts which are numerous and somewhat narrower than in the typical form of the species.

JAMAICA: cultivated at Hope Gardens, *W. Harris*. Pressed specimens in the herbarium of the New York Botanical Garden.

It is of interest to add in this connection that the orange-

bracted *Bihai borinquena* is common in Jamaica along with the red-fruited variety. This Jamaican plant differs but slightly from the Porto Rican type. From it, thanks to formalin specimens and very beautiful colored drawings made by Mr. Harris's assistant, Miss H. A. Wood, I am able to describe the flower which, by a typographical error, was stated to be 11 cm. long in the original description:

Flowers about fifteen, bracteoles yellow, firm when fresh, ovate-triangular, enveloping the flower; ovulary yellow, perianth 6 cm. long, white below, green on the exposed tips, bent somewhat toward the posterior sepal, with a conspicuous subgibbous expansion on the anterior side, filaments conspicuously bent into the expansion, perianth segments free above but partially fused below, staminode about 3 cm. long, reaching to the bend in the filaments; berry dark blue, 10 × 13 mm., pedicel stout, fleshy, ringed, about 25 mm. long at maturity, seed 10 × 4 mm., tubercled, horny.

Bihai stricta (Huber) comb. nov.

Heliconia stricta Huber, Bol. Mus. Goeldi 4: 543. 1906.

TYPE LOCALITY: "Esta especie é bastante frequente nas fraldas do Cerro de Couchahuya; ella é cultivado no horto botanico do Museu Goeldi."

Bihai stricta is evidently closest to *B. humilis* but differs in the much wider branch-bracts.

Bihai adflexa sp. nov.

Plant of medium size, leaves 60–80 cm. long, 15–20 cm. wide, oblong, narrowed to the base, tip not seen, green and glabrous on both sides, main veins prominent, 5–7 mm. apart: inflorescence deltoid, stiffly erect, peduncle apparently elongated, about 8 mm. in diameter, glabrous, rachis stiffly zigzag, puberulent, middle internodes about 15 mm. long, bracts twelve in the type, all ascending, scarlet, somewhat puberulent on the back, narrow, linear-oblong, obtuse, revolute, little concave, strongly bent upward near the base, whence the name, middle bracts about 7 cm. long, scarcely 2 cm. wide, the upper much smaller, the lower much larger: flowers numerous, bracteoles persistent, 4 × 1 cm., with a thin evanescent pubescence both within and without; perianth 4 cm. long, sparingly pubescent like the bracteoles, sepals free, corolla limb three toothed. [TEXT FIG. 5.]

GUATEMALA: Coban, altitude 1,600 m., in deep forest, June

1908, *H. von Tuerckheim II 2356*. Type in the herbarium of the New York Botanical Garden.

The very narrow revolute bracts at once distinguish *B. adflexa* from all other species of the genus except *B. lingulata* and *B. revoluta*.

FIG. 5. ***Bihai adflexa*** **Griggs; about half natural size.**

There is small likelihood of its being confused with *B. revoluta* with its elongated, lax, pendent inflorescence. The resemblance to *B. lingulata* is closer but that species has larger, yellow inflorescence with wider bracts. It is, moreover, Peruvian.

Bihai brasiliensis pulverulenta (Lindl.) var. nov.

Heliconia pulverulenta Lindl. Bot. Reg. **19**: *pl. 1648*. 1833.
Hook. Bot. Mag. **78**: *pl. 4685*. 1852.
Bihaia pulverulenta Kuntze, Rev. Gen. Pl. **2**: 685. 1891.

In every detail except its slightly inferior size and its heavily farinose leaves *B. pulverulenta* corresponds precisely with *B. brasiliensis*. Although recognizing that glaucescence was sometimes evanescent and variable in amount, I have heretofore supposed that marked differences in this matter were sufficient criteria of specific distinctness. But the correspondence between these two species is so exact in every other respect that one has no other recourse than to throw them together. A specimen brought back from Rio de Janeiro by the United States Exploring expedition under Captain Wilkes is very interesting in this connection. It has the typical inflorescence of the two species; some of the leaves are cordate but others are narrowed to the base; some of them were clearly green and glabrous but others show evident signs of a heavy pulverulence which has been rubbed off except in a few protected spots! The reason that the similarity of the two plants was not recognized long ago is that glaucescence was made a primary character in the key so that they were never put close enough together to invite comparison.

Bihai angusta (Vellozo) comb. nov.

Heliconia angusta Vellozo, Fl. Flum. Text 107. 1825. Plates 3: 20. 1827.

Heliconia bicolor Benth. Maund's Botanist 3: *pl. 101*. No date, 1837–1840? Regel, Gartenflora 5: 289. *pl. 172*. 1856.

Heliconia angustifolia Hook. Bot. Mag. 75: *pl. 4475*. 1849.

Bihai straminea sp. nov.

Plant rather small, erect, habit cannoid, leaves reaching 35 cm. in length and 10 cm. in breadth, smaller in the type, the upper, at least, sessile, elliptical, acuminate, round at the base, glabrous, green on both sides; inflorescence erect, pale greenish yellow, peduncle glabrous, about 18 cm. long in the material seen, 2–3 mm. thick, rachis somewhat zigzag, minutely puberulent, internodes 10–15 mm.; bracts half a dozen or less, ascending, glabrous unless at the base, narrowly triangular, concave and boat-shaped, straight sided, widest at the base, acute, 3–10 cm. long, the largest about 12 mm. broad, tips of the lowest exceeding the uppermost: flowers few, bracteoles about 15 mm. long, less than 5 mm. wide, caducous after anthesis, glabrescent; pedicel, ovulary and calyx thickly and softly pubescent, perianth about 3 cm. long, with a

dark spot near the tip, strongly bent toward the large sepal somewhat as in *B. geniculata*, large sepal rolled back in flower, lateral sepals almost completely fused with the corolla or free, pedicel about 15 mm. (not mature). [TEXT FIG. 6.]

FIG. 6. *Bihai straminea* Griggs; about half natural size.

PANAMA: dry wooded hills around Alhajuila, prov. Panama, altitude 30–100 m. (Smithsonian Survey), January 11, 1911, *H. Pittier 2328* (type in the National Herbarium, sheet 677138); between Miraflores and Corazal, Canal Zone, altitude 20–30 m. (Smithsonian Survey), January 3, 1911, *H. Pittier 2200*.

Bihai Harrisiana sp. nov.

Erect, up to 4 m. tall, habit cannoid, leaves sessile, up to 30 cm. long and 11 cm. broad, broadly elliptical, acuminate, round

at the base, green and glabrous: inflorescence erect, glabrous, peduncle of variable length, rachis somewhat flexuose, internodes about 15 mm. long, bracts few, the lowest fertile one scarcely 10 cm. long, the upper about 6 cm., all about 15 mm. wide, narrowly lanceolate, obtuse or some of them acute, particolored, upper half bright crimson fading into greenish yellow below; flowers few, bracteoles about 20 × 7 mm., early deciduous, perianth 25–30 mm. long, posterior sepal red, fading into orange on the edges and tip, conspicuously spotted with black at the tip, lateral sepals free, red, petals two, sometimes with the rudiment of a third, red, fading into green on the tip, pedicels 10–15 mm. long. [PLATE 19.]

JAMAICA: Leicesterfield, Upper Clarendon, *W. Harris 10841*, February 28, 1910; with the field note, "1,800 ft. alt. An erect growing plant with reed like stems up to 12 feet high, basal third of stems leafless, lower half of bracts orange yellow, upper half bright crimson, rhizome stout, creeping, flowers scarlet, tipped with green and white." (Type in the herbaria of the Ohio State University and the New York Botanical Garden; also cultivated in Hope Gardens, Jamaica.) "Jamaica, *Wilson*"! in Herb. Gray.

In addition to the information contained on the label Mr. Harris has favored me with a letter describing the habitat of the plant in greater detail as follows: "With regard to the new species from the Upper Clarendon I might say that it is fairly plentiful—usually in light shade but sometimes in the open. When growing in shade or partial shade the stems are usually twice as high as those growing in open situations. The most luxuriant clumps I saw were growing in partial shade near the edges of small streams, whilst plants in the open were yellowish in appearance and did not look happy. It is evidently a shade and moisture-loving plant.

"I saw some old stems this year that were fully 2 or 3 feet higher than the specimens measured by me last year, and it would be correct to give the height as 'up to 12 feet or over' and the habitat might be given as the 'upper reaches of the Rio Minho Valley, Upper Clarendon, 1,200 to 2,000 feet altitude.'"

It is a great pleasure to be able to associate with this beautiful species the name of so able and indefatigable a botanist as William Harris.

A dried specimen of *B. Harrisiana* would not ordinarily be distinguished from *B. hirsuta cannoidea* but in well dried material

it is evident that the scarlet of the ends of the bracts does not extend below the middle. The leaves, too, are larger and more broadly oval than in any of the specimens of the variety *cannoidea* (or related species) which have come under my observation while the stature far exceeds anything else recorded in the *Cannoideae*.

Bihai hirsuta (L.f.) comb. nov.

Heliconia hirsuta L.f. Suppl. 158. 1781.

TYPE LOCALITY: "Habitat in America Meridionali."

IMPERFECTLY KNOWN SPECIES

The following species have also been described recently, but the descriptions given are so lacking in diagnostic characters as to make it inadvisable to assign them places in the key:

HELICONIA ROBUSTA Pax; Fedde, Rep. Nov. Sp. 7: 107. 1909

TYPE LOCALITY: "Bolivien Wälder um San Carlos bei Mapiri 700 m. (Buctien n. 1267 flowered July 1907)."

This plant is evidently one of the *Pendulae* but the description is inadequate either to differentiate it from previously described species or to identify it with them.

HELICONIA PEARCEI Rusby, Bull. N. Y. Bot. Garden 6: 494. 1910

"Probably at Santa Ana" (Bolivia).

Said to be "about intermediate between *H. psittacornu* [*psittacorum*] and *H. brasiliensis*." From the description, however, it would appear almost identical with *B. acuminata*.

Explanation of plate 19

BIHAI HARRISIANA Griggs

The figures, natural size, were drawn from specimens flowering in the Hope Gardens, Kingston, Jamaica, by Mr. Harris's assistant, Miss H. A. Wood.

Eugene P. Bicknell

SOLANACEAE

Physalodes physalodes (L.) Britton.

Nicandra physalodes (L.) Pers.

Waste lots and yards on the eastern side of the town. Still in full flower late in September, 1899. At Edgartown, Martha's Vineyard, I have seen it in bloom as early as July 1 and as late as October 12.

*Physalis heterophylla Nees.

Siasconset, a few sterile plants in a mowed field, September 16, 1899.

*Physalis pruinosa L.

In waste ground, scarce, and undoubtedly introduced. Mrs. Flynn has sent me for examination specimens collected by her August 25, 1904, in early bloom, and October 2, 1902, in flower and fruit. On Martha's Vineyard and on Chappaquiddick Island, it is frequent as a garden weed and in soil that has been under cultivation, but I saw it nowhere in surroundings that at all conveyed the suggestion that it might be indigenous. Identification of this and the foregoing species confirmed by Dr. Rydberg.

Note.—Mr. Floyd has informed me that Mr. Dame, in a letter to Mrs. Owen, reported that *Physalis peruviana* L. had appeared at Gibb's swamp in several flourishing colonies in 1895, after an extensive brush fire. No specimens are known to have been preserved.

Solanum nigrum L.

Frequent by street sides and in waste places in and near the town and occasional in other parts of the island; sometimes in the rubbish back of pond shores. Plants very small June 17, 1910, first flowers June 27; remains in flower through September. Common on Martha's Vineyard.

The more usual form of this plant on Nantucket is only slightly pubescent, and has more or less zig-zag and wing-angled stem and branches; the leaves are ovate to lanceolate, often rhombic and attenuate, cuneately narrowed into rather short petioles, and entire to openly low sinuate or irregularly dentate, usually with acutish teeth, the lower surface minutely appressed pubsecent; inflorescence subumbelliform, the flowers 2–6, on strigillose pedicels; corolla white, yellowish-green at the center; calyx lobes ovate-oblong to oblong, becoming 2–3 mm. long, loosely spreading or recurved in fruit; anthers 1.5–2 mm. long, the filaments slightly pubescent; ovary pubescent; style not protruding; berry becoming over 1 cm. in diameter; seeds 1.5 mm. broad. On Martha's Vineyard I have collected a much smaller variety, reduced and more delicate in all its parts; also a larger form, with purplish-tinged flowers.

***Solanum peregrinum** sp. nov.

Similar to *Solanum nigrum*, duller green, rather low, branched from the base, the stem and branches slightly if at all zig-zag, somewhat angled but not winged, roughish with scattered incurving hairs or, above, like the younger parts of the plant, clothed with a whitened strigose pubescence; leaves rather strongly venose, thinly roughish pubescent on both surfaces with loosely appressed hairs, the veins strigose; blades broadly ovate, obtuse, abruptly contracted to slender petioles, sometimes slightly cordate or subhastate, prevailingly deeply dentate with prominent, often regular, obtuse or rounded teeth; inflorescence corymbiform, the flowers six to nine, on finally reflexed strigose pedicels; corolla white, 3–4.5 mm. long, the lobes ovate-oblong, obtuse, densely pubescent on the outer surface, finally recurved; calyx lobes short, 1–1.5 mm., broadly ovate or triangular, usually only obscurely veined, loosely spreading in fruit; anthers pale yellow, 2–2.5 mm. long, the filaments bearded, 1 mm. or more in length; ovary densely white pubescent; style slightly exserted; berry black, becoming 8 mm. in diameter, the seeds 2 mm. broad.

Street sides and waste places in Nantucket where it is rather more common than *S. nigrum*, at least in the town; Surfside; Siasconset. In full flower July 14, 1912; continues in bloom through September. Not seen on Martha's Vineyard. Type: Nantucket street, September 12, 1899, deposited in the herbarium of the New York Botanical Garden.

This plant is evidently introduced on Nantucket and its native habitat is unknown. Whatever may be its history there seems little reason to doubt that it has been included in the species *Solanum nigrum*. Nevertheless I have not found that its characters properly correspond with those of any one of the numerous varieties that have been described of this wide-ranging and polymorphic species. Among the extensive series at the New York Botanical Garden the following are to be referred to *S. peregrinum:*

MONTANA: Columbia Falls, September 17, 1894, R. S. Williams. FLORIDA: Pensacola, August 6, 1901, A. H. Curtiss, "No. 6863, Second distribution of plants of the Southern States," labeled "*S. nigrum* var. *Dillenii*," a very different plant. SWITZERLAND: August 28, 1897, S. L. Clarke.

Solanum nigrum, as now generally accepted, is unmistakably a composite species, and in the subdivision which it must sometime receive the precise application of the collective name will be a matter for very critical determination. The ordinary Nantucket form agrees closely with the description of "true *S. nigrum*" as understood by Dr. Gray.* From this *S. peregrinum* is clearly distinct showing obvious differences throughout—duller green color, coarser pubescence, straighter and less angled stem and branches, shorter and broader, deeply dentate-lobed leaves, the blades abruptly contracted into longer petioles, corymbiform instead of umbelliform inflorescence, broader divisions of the corolla, larger anthers, bearded filaments, shorter calyx lobes, larger seeds.

Comparison of *S. peregrinum* with the type of *S. interior* Rydberg† shows it to be quite distinct from that western species.

SOLANUM DULCAMARA L.

Neglected places in the town; cedar thicket at Monomoy; among pines near Miacomet Pond; the Thorn lot and at several stations on the western side of the island. First flowers June 28, 1912; in full bloom June 15, 1910; late flowers and well fruited September 10, 1907.

LYCIUM VULGARE (Ait. f.) Dunal.

Occasional in waste ground and along fences in and near the

* Syn. Fl. 2^1: 227–228.

† Bull. Torr. Club 31: 641, 1905.

town, and at one place on the harbor shore. In full flower May 30, 1909, June 15, 1911, mid-September, 1899.

DATURA STRAMONIUM L.

Infrequent and apparently never of very strong growth on Nantucket. A few small plants at Siasconset, below the bluff, in 1899, 1904, 1912; small plants by the railroad in Nantucket, 1904; waste ground south of the town September 16, 1907, in full flower.

*DATURA TATULA L.

One small plant in a town barnyard September, 1899; a solitary plant by a streetside in full flower August 10, 1906.

Note.—Petunia axillaris (Lam.) B. S. P. is occasionally to be seen as a transient waif in the town streets.

SCROPHULARIACEAE

VERBASCUM THAPSUS L.

Nowhere abundant, but scattered over the island in dry open places. Spikes beginning to show June 18, 1908; first flowers June 26, 1910, June 28, 1912.

*VERBASCUM PHLOMOIDES L.

Two stout plants together on a bank at Siasconset, June 13, 1908, in full flower, thus earlier blooming by over two weeks than the closely related *Verbascum Thapsus.*

VERBASCUM BLATTARIA L.

Seen only in a grassy yard on North Water Street, September 10, 1907, a number of fruiting plants, and two still in bloom, their flowers white. Mrs. Owen has recorded it from a single station in Nantucket and from Siasconset. It is thus not less scarce today than it was thirty years ago, and is one of a number of common and widely distributed weeds that on Nantucket do not seem to find conditions favorable to their spread.

*CYMBALARIA CYMBALARIA (L.) Wettst.

Linaria Cymbalaria Mill.

Established along old walls at several places in the town. Just in bloom June 16, 1911; in full flower June 5, 1912.

LINARIA LINARIA (L.) Karst.

Linaria vulgaris Hill.

Another one of our common weeds that does not make headway on Nantucket. I have met with it there on only three occasions: in 1899, at Siasconset, a few plants together; in 1904, a single patch on the south shore at the site of the old Surfside hotel; and in 1912, by the Wauwinet road in Squam, a small colony in full flower July 12. As far back as 1888, Mrs. Owen reported it as "not infrequent on the edge of the town," where today, if it has not died out entirely, it must be extremely scarce. It occurs on Tuckernuck and is frequent on Martha's Vineyard, but seems to be absent from Chappaquiddick Island.

LINARIA CANADENSIS (L.) Dumort.

One of the common plants of sandy and sterile soils. First flowers May 30, 1909, June 4, 1911; in full flower June 7, 1908; continues to bloom well into September.

*SCROPHULARIA LEPORELLA Bicknell.

Scarce. In September, 1899, a colony of some twenty plants, the tallest nearly five feet high, grew at the border of a thicket in Squam. Five years later, and many times since then, this station was searched for in vain; probably none of the plants had survived the encroachment of the woody growth that had at first given them protection. Not until 1910 was the species seen again when two spindling flowerless plants were found at Watt's Run. The next year much of it, in full flower on June 9, raised its tall stems along a low shore thicket in Quaise, and on July 5, 1912, a group of some fifteen plants were in full flower in low open ground near Miacomet Pond. Collected in a yard on West Silver street July 1, 1911, by Miss Grace B. Gardner. It occurs on Martha's Vineyard, there being two stations on Chappaquiddick Island.

It is interesting that the wide variation in leaf form to which this species is subject may be seen in its extremes in the small and isolated colonies found on Nantucket. In plants rising side by side the leaves of one may be evenly close-serrate, of the other coarsely and irregularly laciniate, or even doubly laciniate, with salient triangular to lanceolate-attenuate teeth. Even this ragged-

ness of outline may be sharply accentuated by a more prominent tooth here and there standing forth quite out of line with its fellows either at right angles to the axis of the leaf or actually recurved.

The plants of these coastal islands compared with those of more hilly country inland show a marked tendency toward a different form of corolla, the tube wider, even campanulate, with its upper lip abbreviated and with short rounded lobes, much like that of the western *S. occidentalis*, to which this species is evidently very closely related.

GRATIOLA AUREA Muhl.

Abundant on wet shores and in low grounds, as well as in many fresh water ponds, where it develops after the manner of a true aquatic producing lengthened and attenuate semi-pellucid leaves. Young plants beginning to appear May 30, 1909, and June 8, 1910; mostly less than one inch high June 17, 1910; in full flower August 7, 1906, and until after the middle of September. On Martha's Vineyard I have seen it in flower as early as June 26 (1913) and as late as October 8 (1909).

ILYSANTHES DUBIA (L.) Barnhart.

Ilysanthes gratioloides Benth.

Infrequent. Shores of Sachacha Pond; at several stations near Siasconset; Maxcy's Pond; pool on Madequet road. Still in flower September 12, 1907, September 16, 1899.

LIMOSELLA TENUIFOLIA Hoffm.

Abundant on the wet sandy shores of ponds on the south side of the island, especially Hummock Pond; also at Sachacha Pond. Here, and at Miacomet Pond, it may be seen growing beneath the water with elongated attenuate leaves, some of them 10 cm. or more in length. Ordinarily the leaves are mostly 2–4 cm. long and very narrowly linear, either obscurely spatulate or tapering to an obtuse tip. Not yet in flower May 31, 1909; in full flower June 17, 1908, continuing in bloom through September.

*VERONICA OFFICINALIS L.

A small patch in full flower on a lawn on Main Street, June 16, 1911, doubtless introduced.

*VERONICA SERPYLLIFOLIA L.

Infrequent and possibly introduced. Damp fields westward from the town at several stations; Grove Lane; Crooked Lane; Millbrook swamp. In full flower May 31, 1909, June 11, 1911.

*VERONICA PEREGRINA L.

Apparently of very recent introduction. It grew in profusion in a neglected yard at the Springfield House, June 11, 1911, in flower and fruit, but has not been seen anywhere else.

VERONICA ARVENSIS L.

Frequent by streetsides in the town; abundant on a lawn on North Water street, 1910; dry open thickets in Shawkemo, Polpis, and Millbrook swamp. In full flower May 30, 1909, June 7, 1908, June 27, 1910.

*VERONICA TOURNEFORTII Gmelin.

Near Sea Cliff Inn, June, 1893, Mrs. Mabel P. Robinson; Brant Point road "abundant and seemingly established" 1896, Mrs. Maria L. Owen, fide F. G. Floyd.

*VERONICA TEUCRIUM L.

Grove Lane, one plant, 1897, Miss Elizabeth S. Kite, fide F. G. Floyd. An estray from farm house gardens at several places on Chappaquiddick Island. In full flower in September.

*AUREOLARIA PEDICULARIA (L.) Raf.

Gerardia pedicularia L.

A colony of scattered plants in full flower September 16, 1899, in an open growth of scrub oak a mile or more northeast of Siasconset. I have not seen it since on Nantucket, although it is locally common on Chappaquiddick Island, where it continues in bloom sometimes to the middle of October. Doubtless referable to Dr. Pennell's variety *caesariensis*, although no specimens are now at hand for verification.

AGALINIS PURPUREA (L.) Britton.

Gerardia purpurea L.

Common in low grounds, either in damp soil, fresh or brackish, or on dry sandy levels, blooming in August and September and later. The corolla varies much in size and is largest and most pubescent in stout and somewhat fleshy horizontally wide branched

plants of brackish soils which also develop relatively large broadened capsules; the largest corollas seen were 3.8 cm. long and of equal width.

*AGALINIS PAUPERCULA (A. Gray) Britton.

Gerardia paupercula Britton.

Flowering specimens collected August 16, 1906, in damp places in the hills south of Polpis, have been determined by Dr. F. W. Pennell. I met with it nowhere else on Nantucket where it can scarcely be other than a scarce and local plant.

AGALINIS MARITIMA Raf.

Gerardia maritima Raf.

Locally common in many salt marshes along the north shore of the island; the Creeks; Swain's Neck and Bache's Harbor; Eatfire; Pocomo; Coskaty; Little Neck. Blooms in August and September.

***Agalinis acuta** Pennell, sp. nov.

"Annual. Plant light green, not tending to blacken in drying. Stem 1–4 dm. tall, simple or moderately branched, rather conspicuously striate four-angled. Leaves opposite, linear, slightly to moderately scabrous above; those of the stem 1–2.5 cm. long, 0.6–1.3 mm. wide. Pedicels slender, in flower 5–15 mm. long, in fruit 12–20 mm. long, 1–2(–3) times the length of the bracts. Calyx-tube 3 mm. long, evidently reticulate-veiny (firmer in texture than in *A. decemloba*), ⅔–¾ the length of the capsule, its lobes 0.5–1 mm. long, triangular-acuminate, not or scarcely callose. Corolla 10–13 mm. long, membranous, its tube 7–9 mm. long, its lobes 3–4 mm. long, retuse to emarginate, all spreading; within pubescent below sinus and over entire width of basal portions of posterior lobes; posterior lobes ciliate, anterior finely ciliolate; "rose-pink" (not seen fresh). Filaments lanose toward apex, anterior more densely so; anther-sacs lanose with white hairs on the valvular surface, glabrous on the sides. Style glabrous. Stigma 1–1.2 mm. long. Capsule 3.8–4.2 mm. long, ovoid, yellowish-brown. Seeds 0.4–0.6 mm. long, triangular-rounded, turgid, yellowish-brown; testa finely reticulated.

"Type: dry sandy downs, Edgartown, Martha's Vineyard, Massachusetts, collected in flower September 12, 1901, M. L. Fernald, 45 in United States National Herbarium; cotypes in Gray Herbarium and Herbarium New York Botanical Garden.

"Flowers, late-August to October. Fruit, late-September to October. Dry sandy soil, rare or locally frequent in the Coastal Plain, Cape Cod region of Massachusetts, Nantucket, Martha's Vineyard and Long Island, westward as far as the Hempstead Plains; very occasional inland (above the Fall-Line) in eastern Massachusetts, Rhode Island and Connecticut.

"Differs from *Agalinis decemloba* (Greene) Pennell, which occurs from Lancaster County, Pennsylvania, to northern Alabama, by its lower habit, pedicels mostly 1–2 (not 2–3) times the length of the bracts, calyx-tube campanulate (not hemispheric), firmer in texture, $\frac{2}{3}$–$\frac{3}{4}$ (not $\frac{3}{5}$–$\frac{2}{3}$) the length of the capsule, calyx-lobes 0.5–1 mm. (not 0.05–0.2 mm.) long, not or scarcely callose, and its seeds smaller, 0.4–0.6 mm. (not 0.6–0.8 mm.) long, strongly (not obscurely) reticulated.

"Differs from *Agalinis Skinneriana* (Wood) Britton, which occurs from the St. Clair River, southwestern Ontario to eastern Kansas, by its less conspicuously striate-angled stem, angles glabrous or nearly so (not scabrellous-roughened), its corolla-lobes more or less emarginate (not truncate), stigma 1–1.2 mm. (not 1.5–2 mm.) long, capsule 3.8–4.2 mm. (not 4–5 mm.) long, and seeds smaller, 0.4–0.6 mm. (not 0.7–0.9 mm.) long." *Francis W. Pennell.*

A characteristic autumn-flowering plant of the dry plains in the southern half of the island; on the north side observed only in Pocomo. In full flower September 2, 1904, continuing in bloom through the month. Common also on the south side of Martha's Vineyard and on Chappaquiddick Island. Well grown plants become much branched and 3 dm. in height; diminutive examples may be not over 2 cm. high with only a terminal flower.

Comparison of Nantucket specimens collected in 1904 with Wood's type of *Gerardia Skinneriana* in the herbarium of Columbia University, to which species the New England plant had long been referred, showed that they were not at all the same; and when, through the kindness of Professor Greene, I received specimens of his then recently described *Gerardia decemloba*, from Washington, that more nearly related plant was readily seen not to be identical. Dr. Pennell's studies in this group have brought him quite independently to the same conclusion, and have shown further that our eastern plant, and *A. decemloba* as well, are

distinct from the more southern *Agalinus parvifolia* (Chapm.) Small, to which both had been recently referred.

SCHWALBEA AMERICANA L.

Mrs. Owen's catalogue contains the record of all that is known of this plant on Nantucket: "Plains opposite Bloomingdale; rare, L. L. D. Plants of luxuriant growth but few in number." It has never been reported by any other collector than Mr. Dame.

PEDICULARIS CANADENSIS L.

Frequent in dry thickets and open ground throughout the eastern side of the island from Pocomo and Squam to Siasconset; Quaise; near Madequecham Pond. Observed in full flower from June 4 to 15.

MELAMPYRUM LINEARE Lam.

An inhabitant of dry thickets and copses on the eastern side of the island from Shimmo and Shawkemo to Squam and Siasconset. Just in flower June 2, 1909, June 7, 1908; still in bloom July 11, 1912.

LENTIBULARIACEAE

UTRICULARIA MACRORHIZA LeConte.

U. vulgaris var. *americana* A. Gray.

Reed Pond; Maxcy's Pond; pool west of the town; reported from Polpis by Mrs. Owen. In flower at Reed Pond June 8, 1908, June 18, 1910, July 3, 1912, September 10, 1907.

UTRICULARIA GEMINISCAPA Benj.

U. clandestina Nutt.

In a ditch on Swain's Neck, also in Polpis; not seen in flower. "Ditches in Polpis choked with it." M. L. O. catalogue.

UTRICULARIA INTERMEDIA Hayne.

"A single non-flowering specimen in Reed Pond. Morong, 1887." M. L. O. catalogue.

SETISCAPELLA SUBULATA (L.) Barnhart.

Utricularia subulata L.

Taupawshas swamp in open places among masses of cranberry, both in wet spots and in merely damp soil, July 6, 1912, just in flower. Reported by Mrs. Owen in her catalogue from Tom

Never's and Gibb's Ponds, where it was collected by Mr. Walter Deane (see Rhodora, 6: 160).

SETISCAPELLA CLEISTOGAMA (A. Gray) Barnhart.

Utricularia cleistogama Britton.

Mrs. Owen, in her catalogue, has reported her discovery of this diminutive plant on Nantucket, where she had found it in abundance in a part of Tom Never's swamp and also at Almanac Pond. Flowering specimens, sent by Mrs. Owen, as I am informed by Professor Fernald, are preserved in the Gray herbarium together with a letter from their collector dated August 28, 1881. The citation of the plant from Nantucket in the sixth edition of Gray's manual evidently rests on this material.

Although now held to be a species distinct from *S. subulata* it cannot be said of this plant that it is yet conclusively known to be anything more than a reduced state of that species. Whatever the truth may be the two plants do not always show that wide diversity in their corollas that, by comparison of typical examples, does undoubtedly seem to attest them as distinct. Near Edgartown, on Martha's Vineyard, on September 30, 1912, there fell to me a most favorable opportunity of observing the extent of variation natural to the flowers of *S. cleistogama* among the plants of a single colony. The situation was a few square feet of damp sandy soil in open ground. In the weakest examples, some of them not over 1 cm. high. the corollas, "not larger than a pinhead," were subglobose or saccate, and white or faintly bluish in color, precisely as descriptions require them to be. But in stronger plants the corollas increased doubly in size and came also, by an exact gradation, to a distinctly two-lipped form, the blunt lower lip dusky or purplish lineate and with an evident white spur, the most open flowers showing an unmistakable yellowish tinge. The spur, obsolete in the smallest corollas, varied in the larger ones from rounded to oblong and acutish; in one instance it was bifid.

In very small examples of *S. subulata*, unmistakable as to identity because components of colonies of the typical plant, the corolla, perhaps from arrested development, may be somewhat abortive and reduced to a fraction of its normal size, and is sometimes palest yellow, or even whitish with a faint bluish tinge.

Such plants were collected on Martha's Vineyard, near Lambert's Cove, July 1, 1913.

OROBANCHACEAE

*THALESIA UNIFLORA (L.) Britton.

Orobanche uniflora L.

Probably not uncommon, although not previously reported from Nantucket. On June 4, 1909, when it was in full flower and therefore easily noticeable it was found along the foot of Rattlesnake bank, and also by a low thicket in Shawkemo and on an open sandy hillside eastward towards Polpis.

Note.—The beech-drops, *Leptamnium virginianum* (L.) Raf., grows in association with almost all the groups of beech trees on Chappaquiddick Island, and is abundant at several stations and of strong growth, some plants attaining a height of 5 dm. On Nantucket I have never missed an opportunity of seeking it wherever beech trees were seen but always without success. It seems altogether probable, however, that some day it will be discovered there.

BIGNONIACEAE

*CATALPA CATALPA (L.) Karst.

Catalpa bignonioides Walt.

Small trees not over three feet in height, were observed, in 1904 and 1906, scattered among an extensive growth of pines east of the town; a single small tree among introduced pines at Wauwinet, 1912.

PLANTAGINACEAE

PLANTAGO RUGELII Dcne.

Reported in Mrs. Owen's catalogue as "very scarce" and found, by Judge Churchill and Mr. Dame, only at two stations at the southern end of the town. I did not succeed in finding it until 1907 when, in September, a few flowering plants were observed in a shaded yard on Broad Street. Two years later it had become established by nearby streetsides at several places, and was also seen in a farmyard south of the town and at as far distant a point as a thicket in Shawkemo.

PLANTAGO MAJOR L.

A weed of roadsides, old fields and waste places. July to September.

*PLANTAGO HALOPHILA Bicknell.

A characteristic plant of salt marshes and brackish shores, sometimes extending along roadsides. Flowering during August and September.

PLANTAGO LANCEOLATA L.

Excessively abundant in fields and grassy places everywhere. Dark green glabrate plants and paler and narrower leaved very hairy forms, mainly of poorer soils, constitute markedly divergent varieties of this species. Forms with dark, ovate, compound heads are frequent, as well as sharply contrasting forms having the spikes linear and elongated. Blooms from May until October.

PLANTAGO DECIPIENS Barneoud.

Frequent or, locally, rather common in salt marshes and along shores, blooming from August through September.

*PLANTAGO ARISTATA Michx.

A few plants on Little Neck, September 10, 1904, in flower and fruit; near Brant Point, September 13, 1907; one plant in a waste yard June 27, 1910; a scattered growth in a dry field in Shawkemo, in full flower July 1, 1912. Abundant and evidently long established on Martha's Vineyard, and also extending all along the sandy roadway that crosses Chappaquiddick Island, but on Nantucket apparently of only recent introduction.

RUBIACEAE

HOUSTONIA COERULEA L.

Abundant throughout, not only in low moist places but also over the dry plains and commons, and to the tops of the exposed rolling hills. In the southwest quarter of the island it even overspreads the sandy wastes near the shore, in association with *Sisyrinchium arenicola*, these being the most noticeable plants flowering there in early June. In full flower May 30, 1909; it continues quite generally in bloom into July, and produces belated flowers in August and even in September.

Large flowered forms having white, brightly yellow-eyed corollas, with relatively short, evenly graduated tube, seem to answer quite exactly to the description of var. *Faxonorum* Pease & Moore.

HOUSTONIA LONGIFOLIA Gaertn.

Recorded by Mrs. Owen from "near Long Pond. L. L. D[ame]." No other collector has reported it. About Long Pond are conditions of soil and surroundings suggestive of localities on Long Island where this is a characteristic plant, but I have not succeeded in rediscovering it on Nantucket where, if it occurs today, it must be of extreme rarity.

CEPHALANTHUS OCCIDENTALIS L.

A common shrub of wet swamps and the borders of muddy ponds. Leaves appearing June 7, 1911, June 8, 1908; flower heads less than half size July 4, 1912; still in bloom September 10, 1907.

MITCHELLA REPENS L.

A scarce plant on Nantucket where I have met with it only twice. In 1910 a small patch was discovered in a dense thicket near the head of Tom Never's swamp, and a few plants in a secluded spot at Beechwood, in Polpis. It had not flowered at either station. Mrs. Owen has reported it from Trot's swamp and from Polpis.

*GALIUM ERECTUM Huds.

On Grove Lane, June 28, 1912, a large mass in full flower.

*GALIUM APARINE L.

Everywhere in shaded thickets on banks and in low grounds. In full flower May 30, 1908, May 31, 1909; well fruited June 28, 1912; by midsummer only the withered stems are to be found. Varies remarkably in proportions and in the size of the leaves and fruit.

GALIUM PILOSUM Ait.

Frequent, especially in the northwestern quarter of the island. Not yet in flower June 26, 1910; past flowering and with mature fruit September 2, 1904. Varies from densely pubescent to almost glabrous, the more pubescent forms occurring in exposed

sandy places and in pure sand. The glabrate plants are not common and are found in more protected situations among open growths of scrub pines. Their stems are shining and sometimes quite glabrous, their leaves hispidulous ciliate on the margins and on the midrib beneath, var. *puncticulosum* (Michx.) T. & G.

GALIUM TRIFLORUM Michx.

Frequent in shaded thickets on the eastern side of the island, especially in Squam, Shimmo and Polpis. In full flower and with young fruit August 13, 1906. As elsewhere two forms may be distinguished, the leaves of one narrow and tapering, of the other broadened and rounded or abruptly narrowed to the cuspidate apex.

GALIUM CLAYTONI Michx.

Common in low grounds flowering from the middle of June through September.

The ordinary form of this bedstraw is a small plant of damp or wet open places often where the soil loses much of its moisture or becomes quite dry in summer. In partial shade, or in very wet situations, which encourage a vigorous growth throughout the season, it comes to an enhanced phase of development that gives it quite the aspect of being a different species. Nowhere have I seen this larger state of the plant of more pronounced character than on Nantucket.

The more common smaller form of the plant is very scabrous and of a pale green color, not readily discoloring when pressed; the leaves are often firm with revolute margins, those of the stems sometimes reduced to fours and only 8–10 mm. long and 1–2 mm. wide; the minute flowers of three- or, not rarely, four-parted corollas, are in pedunculate clusters of three on short finally divergent pedicels 2–5 mm. long, and the fruit is 1 mm. or less in diameter. The larger form is only slightly scabrellous and is thin leaved and deeper green in color, turning dark or black on the herbarium sheet. In its luxuriance of growth along ditches and in very wet spots it sometimes forms close masses 6 dm. or more in height, from which it is possible to disentangle individual plants as much as 13 dm. in length. The leaves, in whorls of six on the stems and four on the branches, are narrowed into evident petioles, and be-

come as large as 3 cm. long and 6 mm. wide; the corolla, 1.5–2 mm. in expanse, is four-parted or, in smaller flowers, three-parted, the lobes either acute or obtuse; the fruit 1–1.5 mm. in diameter, is borne on slender spreading pedicels sometimes fully 12 mm. in length which are disposed to be arcuate and slightly scabrous. Smaller and narrower leaved plants having pedicels of this character so closely simulate *Galium trifidum* L. that they might easily be misidentified. It would be hard to believe of these divergent phases of *Galium Claytoni* that they were other than well-defined species, were it not that the gradation from one to the other is gradual and complete and did not as many examples lie midway in the range of variation as at either extreme. Almost the same extent of variation in the species may be observed on Long Island and about New York. If it be thought expedient to recognize the larger form by a name we have for it the varietal designation *Galium Claytoni* var. *subbiflorum* Wiegand (Rhodora **12**: 228–230. 1910).

It could be wished that the name *Galium Claytoni* were better accredited in its application to this plant for which we have come to use it. A careful reading of Michaux's description leaves little doubt in my own mind that his *G. Claytoni* was no other plant than the *G. trifidum* of Linnaeus. Michaux was particular to emphasize of his species that its leaves were in fours or, rarely, in fives, never in sixes, thus meeting exactly the case of *G. trifidum;* and it is further suggestive in his description that the rather ambiguous phrase "*fasciculus ramorum terminalibus*" at once becomes clear and at the same time diagnostic of *G. trifidum*, if we may understand it to mean that, except at the ends of the branches, the flowers were solitary. Upon these indications, and others not necessary now to bring forward, there would seem to be little reason to doubt that the species we have been calling *Galium Claytoni* has never received a name proper to its own identity, unless, indeed, it should bear the name *Galium tinctorium* L., now otherwise appropriated. Bigelow and some others of our earlier botanists took this view, that is to say, their descriptions make it plain that this name was understood by them as applying to the larger phase of the plant now called *G. Claytoni;* and, as a matter of fact, the description of *G. tinctorium* in Species Plantarum

undoubtedly applies better to this plant than to the species that has come to bear it, and which Bigelow described as *Galium obtusum*. It is to be hoped that there may be still in existence original specimens by which the true application of these names may be made clear.

On Nantucket the smaller form of *G. Claytoni* comes into bloom rather earlier than the larger one—June 15, 1908, June 18, 1910; the latter showed its earliest open flowers June 26, 1910.

Galium tinctorium L. (*G. obtusum* Bigelow) occurs on Martha's Vineyard and is to be looked for on Nantucket.

*GALIUM PALUSTRE L.

Abundant in the meadows about Shawaukemmo Spring, where, in June and early July, it is conspicuous from its clustered masses of white bloom about springy places and along runs and rills; also found near Abram's Point. Just in flower June 8, 1911; in full bloom June 25, 1910, July 1, 1912. Flowers cymulose clustered, the corollas spreading 2–5–4.5 mm., four-parted, the lobes acute; flower buds often purplish-pink or rose color.

Note.—Galium circaezans Michx. is included, by name only, in Mrs. Owen's list. It is not known that it has ever been collected on Nantucket.

*SHERARDIA ARVENSIS L.

In full flower all through the short grass of a lawn on Chester street, June 15, 1910.

CAPRIFOLIACEAE

SAMBUCUS CANADENSIS L.

Very common both in moist and in dry thickets and among the scattered patches of bayberry and mixed growth on the open plains. Not yet in bloom June 27, 1910; cymes whitening June 30, 1912, the first open flowers July 4, in showy bloom July 10; still some flowers August 4, 1906; fruiting well September, 1907.

VIBURNUM DENTATUM L.

In swampy thickets, as well as in dry places, and even in pine barrens; often growing with *V. venosum*, but much less abundant and blooming somewhat earlier. Cymes close and green June 7, 1908; just in flower June 22, 1910; bearing green fruit, no flowers

remaining, July 12, 1912. In the autumns when I have observed it it has fruited much less freely than *V. venosum*.

VIBURNUM VENOSUM Britton.

A noteworthy shrub of Nantucket abounding throughout in damp thickets, on dry banks and in open ground; also in pine barrens. Cymes small and green June 7, 1908; forward bushes just in flower June 30, 1912, everywhere in showy bloom July 4 to 13, and later; fruiting abundantly in September.

The leaves show great diversity of size and form, even in shrubs growing side by side, and the fruit is no less variable, sometimes globose, again oval and somewhat pointed. The largest shrubs seen measured 22 cm. around the trunk near the base and were over 3.5 m. in height. The type of this fine shrub was collected on Nantucket, September 19, 1899. It occurs also on Tuckernuck, and is much more common on Martha's Vineyard than *V. dentatum* which it replaces completely on Chappaquiddick Island.

Reported in Mrs. Owen's list under the name *V. molle* Michx.

*TRIOSTEUM PERFOLIATUM L.

Another native plant that has been found only at a single station on Nantucket—at the foot of a steep thicketed bank by a small pond near Acquidness Point. Here, on September 11, 1907, were two strong clusters not two feet apart consisting together of about twenty stems. Two years later it was seen that these plants were succumbing to the closer pressure of the investing woody growth, and in 1911, when I last visited them, one group had been reduced to three, the other to six weakened stems. In 1910 the plants had still been able to bloom, but bore flowers with light yellow corollas instead of the normal red ones they had produced in their days of vigor. Flower buds just visible June 2, 1909; nearly open June 7, 1908; in full bloom June 19, 1910.

LINNAEA AMERICANA Forbes.

Mrs. Owen says of this plant: "A patch 15–20 feet in diameter discovered in the pines in 1868 or 1869 by Mr. L. L. Dame. A patch in the pines on the South Shore road discovered in 1872 by Miss C. L. Tallant." At the latter locality the plants were seen not more than two years, and Mr. Dame looked in vain for

his plants in 1886. Mr. Floyd writes me that "Mrs. Owen told me not very long before her death that the plant still persisted at one station on Nantucket."

*SYMPHORICARPOS SYMPHORICARPOS (L.) MacM.

Symphoricarpos vulgaris Michx.

"Road opposite Barzilliai Coffin farm September 1, 1912, in full flower. Miss Grace Brown Gardner."

*LONICERA JAPONICA Thunb.

Occasional by fence rows and roadsides in the general town region, less often by fieldsides and the borders of meadows. In full flower June 27, 1912.

CUCURBITACEAE

MICRAMPELIS LOBATA (Michx.) Greene.

Occasional in waste places in and near the town. In full flower late in August.

SICYOS ANGULATUS L.

At a few places in damp lots and by fences in the town; by the railroad in Washington street.

CAMPANULACEAE

*CAMPANULA RAPUNCULOIDES L.

Occasional by street sides and in waste ground in the town, more rarely by roadsides in the suburbs. First flowers June 27, 1910, June 29, 1912; in full bloom at the end of August, 1904.

SPECULARIA PERFOLIATA L.

Rare: Acquidness Point, knoll and hillside thicket east of Shimmo farm, June 7, 1911; Rattlesnake bank, July 1, 1912. Only a few plants at each station and no petaliferous flowers.

LOBELIACEAE

LOBELIA CARDINALIS L.

A few plants along Watt's Run September 6, 1904, and much of it in flaming bloom at the same locality September 17, 1907; Quaise and Polpis, M. L. O.

Note.—Lobelia inflata L. is included in Mrs. Owen's catalogue. Nothing is known of it as a Nantucket plant at the present day, nor have I seen it on Martha's Vineyard.

Notes on Michigan Liliaceae*

Oliver Atkins Farwell

(WITH PLATE 20)

NEW VARIETIES OF ALLIUM CANADENSE

In Michigan there are three well-defined races or varieties of the common wild garlic, *Allium canadense* L. The type, with narrow leaves and numerous, small, ovoid, whitish, obtuse or acutish bulblets in the simple umbel; a form with noticeably broader leaves but with fewer, larger, long-acuminate bulblets which are red at maturity; and a larger, glaucous, form with more fleshy leaves, often with two or three sessile, contiguous umbels, which bear a larger number of obovoid or nearly spherical bulblets of a yellowish white color. There is such a marked difference in the appearance of these forms, at least in the living state, that it seems advisable to name them and place them on record.

Allium canadense ovoideum var. nov.

Bulb ovoid, about 19 mm. long, outer coats fibrous-reticulated, 5–8 cm. below the surface; plant 3–4 dm. high, green, with four or five leaves near the base, these equalling the scape or a little shorter; umbel terminal, mostly of a few, twelve or less, large, ovoid-acuminate, sessile bulblets with or without a few long-pedicelled flowers and some secondary umbels of one to three bulblets, on long rays 5–10 cm. long; involucre of one to three ovate, acuminate, scarious bracts, 2.5–4 cm. long; bulblets of the umbel gradually tapering from a broad base, the larger about 22 mm. in length, mostly rose colored at maturity; generally there are no flowers but some umbels may have from one to four, and occasionally there may be one in one of the umbellets; the flowers are pale purple, on pedicels 5 cm. in length, 8 mm. across when open, 5–6 mm. high; segments acute, the outer narrowly ovate, the inner oblong or linear.

On wet banks in open fields. Michigan: near Rochester, June 11, 1914, *Farwell 3667*.

* Contributions to the Botany of Michigan, No. 12.

Differs from the typical form of the species in its large long-acuminate, rose-colored bulblets, in the narrower perianth-segments and longer pedicels.

Allium canadense robustum var. nov.

Bulb spherical or nearly so, 2.5 cm. in diameter or less, the outer coats fibrous-reticulated, deep-seated, 15–18 cm. below the surface; scapes, often two, 3–4.5 dm. in height, 6 mm. or less in diameter, and, with the two to six leaves near the base, glaucous; leaves rather fleshy, 6 mm. wide, channelled above, convex below, two thirds to three fourths the length of the scape; scape bearing one to three sessile, contiguous umbels, mostly of bulblets, at its apex with one or more rays, 12.5 cm. or less in length, each bearing an umbellet of from one to three bulblets; bulblets often foliaceous, from spherical or nearly so to obovoid, tipped with a minute curved point, the larger about 12 mm. in longest diameter, very numerous, often more than thirty, yellowish white; involucre one to four ovate, acuminate scarious bracts, the acumination often prolonged to a length of 7.5 cm.; flowers, when present, few, on pedicels 19–38 mm. long, white or pale rose, 7 mm. high, 10 mm. across when open, segments obtuse, the outer ovate, the inner oval or obovate.

In rather moist meadow lands. MICHIGAN: near Rochester, June 9, 1912, *Farwell 2629;* June 13, 1912, *Farwell 2729;* June 11, 1914, *Farwell 3666.*

Differs from the typical form of the species in its more robust habit, compound umbel with differently shaped bulblets, obtuse petals and general glaucousness. Listed as *Allium rubrum* Osterhaut? in Rpt. Michigan Acad. Sci. **15**: 169. Nov. 1913.

NEW SPECIES OF LILIUM

I have long considered that the wild red lily of the middle west is specifically distinct from the yellow-flowered *Lilium canadense* L. of the Atlantic seaboard.

Our plant is much taller and coarser; the flowers generally are strongly revolute and red instead of yellow; if the two plants were specifically the same, it would be reasonable to expect to see a yellow-flowered individual at times in the middle west but such has never come under my observation during the twenty-five years I have been observing these plants. I had become so thoroughly

imbued with the idea that our red lily of the middle west was the true *Lilium canadense* that when I first saw the smaller, yellow-flowered lily east of the Appalachians, from the window of a slowly moving train, I was unable to recognize it as of that species, it appeared to be so radically different from my conception of what *Lilium canadense* should be. The red-flowered plant is unquestionably a distinct species.

Lilium michiganense sp. nov.

Leaves remotely whorled, six to ten in a whorl, three- to seven-nerved and rough on the nerves beneath as well as on the margins, lanceolate (12 mm. wide by 9 cm. long) to ovate-lanceolate (19 mm. wide by 4.5 cm. long); flowers in a pyramidal cluster (two to four axial from the uppermost whorl and about four racemosely disposed on the terminal portion of the stem), the peduncles 10–12 cm. long, often bearing a foliaceous bract near the middle.

MICHIGAN: Wiard's Crossing, July 9, 1910, *Farwell 2162½*.

Similar to *L. canadense* in foliage and to *L. superbum* in its flowers, which are of a beautiful orange-red, copiously spotted inside with purplish brown or crimson spots. The upper leaves of this plant are often smooth on the veins beneath, a transition to *L. superbum*, which, though credited to Michigan, I have not yet detected here. The new species occurs in three well-defined forms, and I have taken the most highly developed form, although not the commonest, as the type.

Lilium michiganense umbelliferum var. nov.

Differs in having the stem end abruptly at the uppermost node, the inflorescence being composed of an umbel only, of from two to five flowers, from the axils of the leaves of the uppermost node.

MICHIGAN: Wiard's Crossing, July 9, 1910, *Farwell 2162⅓*; Birmingham, September 7, 1903, *Farwell 1261c;* Belle Isle, July 16, 1892, *Farwell 1261;* Palmer Park, July 16, 1902, *Farwell 1261b;* Rochester, July 4, 1896, *Farwell 1261a.*

Lilium michiganense uniflorum var. nov.

The simplest form, in which the stem is continued beyond the uppermost whorl of leaves and bears a single, nodding flower.

MICHIGAN: Wiard's Crossing, July 9, 1910, *Farwell 2162¼*;

Rochester, July 14, 1912, *Farwell 2848;* Parkedale Farm, October 5, 1913, *Farwell 3523;* Rochester, July 14, 1913, *Farwell 2848.*

It is a misnomer to call *L. michiganense,* as is usually done here, "the wild yellow lily" as the flowers are never yellow; the buds are at first green, then yellow (some, however, never show any sign of yellow externally), and finally red; the flowers when opened are orange-red externally and on the blade internally, the midvein being orange-yellow, the claw pale yellow or whitish and copiously blotched with crimson spots which extend upward on the blade for one half to two thirds its length. I have included in this species certain forms in which the buds show no yellow color, and the flower has brownish purple instead of crimson spots with orange-red extending down the claw, but in which the leaves are characteristic. Further study may prove these forms to be distinct. The segments are recurved to below the middle, often spirally coiled, so that the apex is again ascending.

Lilium peramoenum sp. nov.

Similar to *L. michiganense*, but the leaves are more numerous, eight to sixteen in a whorl, with a corresponding increase in the number of flowers in the inflorescence; the flowers are orange-red throughout, dotted with copious but smaller spots; the leaves are narrower, linear-lanceolate, 10 mm. wide by 9 cm. long to oblong-lanceolate 15 mm. wide by 7 cm. long.

MICHIGAN: Parkedale Farm, July 19; 1914, *Farwell 3726.* Elder thickets in rich muck lands. *L. michiganense* is found usually in poorer soil though it may be in dry fields and on banks or in wet swamps and meadows. Both species range from 1–2 m. in height.

NOTES ON UNIFOLIUM BIFOLIUM

In Rhodora for December, 1914, Mr. Fernald describes a pubescent form of *Maianthemum canadense* as a new variety (var. *interius*) and gives its range from Illinois north and northwestward into Canada. He had not seen this pubescent form east of Illinois or Wisconsin. The late Mr. G. H. Hicks collected it at Owosso, Michigan, in 1889, and I found it at Stoney Creek, Michigan, in 1913. Both stations are in the southeastern part of the state, about sixty miles apart.

A careful study of a series of specimens, ranging from Oregon to Hungary, allows of but one conclusion—that there is but a single species and that the plant recently described by Mr. Fernald as *Maianthemum canadense* var. *interius*, is, in reality, identical with the Linnean *Convallaria bifolia* and is, consequently, *Unifolium bifolium* (L.) Greene. The plant from the Black Hills, FIGS. 7, 8, it will be observed, corresponds with that from Denmark, FIG. 6; the collections of Mr. Hicks, FIGS. 9, 10, are nearly identical with those from Hungary and Bavaria, FIGS. 1, 2; and my own collection from Stoney Creek, FIG. 11, is very close to another plant, FIG. 3, from Bavaria; the outlines of the leaves of the var. *canadense*, FIGS. 12–19, are the same as those of the type, no other difference, save that of pubescence, being detectable; the apex in both is acute or obtuse, the base cordate or sagittate; the western variety *kamtschaticum*, FIGS. 22, 23, shows the broadest sinus; the European type, the deepest; the var. *canadense*, the shallowest; and the var. *ovale*, FIGS. 20, 21, the narrowest; but there is a regular graduation from one extreme to another. The var. *kamtschaticum* has the longest petiole with the blade prominently decurrent on it; the plants of Loher, FIG. 3, and Cavassius, FIG. 4, show the blades slightly decurrent on the petioles, thus in a measure paralleling the western form. The pedicels vary from 2–6 mm. in length in all the forms; the petioles of the upper leaf measure 1–6 mm., and of the lower leaf, 2–16 mm., in all the forms except the western, which has much longer petioles. There is in Michigan a plant with broadly ovate or oval leaves, FIGS. 20 (stem-leaf), 21 (root-leaf); Pursh traversed the region of "the Lesser and Great Lakes" and I have no doubt that this form is the basis of his *Smilacina canadensis* var. *ovalis;* the base of the leaf is cordate or rather sagittate but the sinus is closed or nearly so, which renders it inconspicuous. There is a form which has three leaves to the stem and in Europe forms are found with but one leaf. The differences in length of petioles, pedicels, and the size of the leaf-sinus cannot be correlated with other characters with a sufficient degree of accuracy to warrant separating the different forms as species; such differences as exist are of degree and not of kind and therefore are not of specific value. The species and its forms may be listed as follows:

UNIFOLIUM BIFOLIUM (L.) Greene

Maianthemum canadense var. *interius* Fernald, Rhodora **16**: 211. 1914.

MICHIGAN: Owosso, May 21, 1889, *G. H. Hicks;* Stoney Creek, May 25, 1913, *Farwell 3412.* Illinois westward to the Black Hills and northward into Canada; also in Europe.

Unifolium bifolium monophyllum forma nov.

Differs from the species only in having but one leaf on the stem. SWEDEN: Moheda, *C. G. H. Cavassius*, in the herbarium of Parke, Davis & Company.

Unifolium bifolium canadense (Desf.) comb. nov.

Maianthemum canadense Desf. Ann. Mus. Paris **9**: 54. 1807.

Convallaria bifolia var. *canadensis* Poir. Enc. **4**: 371. 1816.

MICHIGAN: Detroit, May 9, 1895, *Farwell 379a;* Algonac, September 13, 1914, *Farwell 3898.* From Michigan eastward, ranging north to Newfoundland and south to the Carolinas.

Unifolium bifolium trifolium (Pursh) comb. nov.

Smilacina canadensis γ *trifolia* Pursh, Fl. Am. Sept. 233. 1814.

The stem has three leaves, otherwise like the variety *canadense*.

MICHIGAN: Detroit, May 9, 1895, *Farwell 379b.*

Unifolium bifolium ovale (Pursh) comb. nov.

Smilacina canadensis β *ovalis* Pursh, Fl. Am. Sept. 233. 1814.

I here adopt Pursh's varietal name for the form in the Lake Superior district, with broadly ovate or oval leaves.

MICHIGAN: Keweenaw Peninsula, June, 1886, *Farwell 379;* October, 1914, *Farwell.*

UNIFOLIUM BIFOLIUM KAMTSCHATICUM (Gmel.) Piper

California to Idaho and Alaska; also Siberia.

NOTES ON VAGNERA

VAGNERA STELLATA (L.) Morong

The common woodland form, 3–4.5 dm. in height, bearing seven to twelve leaves with a short, harsh pubescence on the veins on the lower surface, becoming, with age, glabrate or smooth, at least to the touch.

MICHIGAN: Ypsilanti, May 29, 1891, *Farwell 1121;* Parkedale Farm, May 19, 1912, *Farwell 2567;* Rochester, June 28, 1914, *Farwell 3699.*

This I take to be the typical form of the species. There is a wide range in the size of the plant and leaves, in the pubescence, and in the habitat of this species; the rhizome seems to vary in size correspondingly; the fruit, while young, is green; but as it approaches maturity it becomes purple on the angles; then intermediate lines of a paler color appear; later it is finely lined or spotted and ultimately becomes a ruby red as in *V. racemosa* and the other species of the genus. Fruit, however, in this species is a rarity; most of the flowers are sterile and drop from their pedicels at an early stage as though the plant were of hybrid origin; if such is the case the parents probably are *V. racemosa* and *V. trifolia.*

Vagnera stellata mollis var. nov.

Differs from the typical form of the species in having the leaves densely and permanently velvety pubescent all over the lower surface; in the more numerous leaves, six to fourteen, 1–5 cm. wide and 3.5–20 cm. long; plant often larger, attaining a height of nearly 1 m., but sometimes smaller and not exceeding 18 cm.

MICHIGAN: Parkedale Farm, May 30, June 11, and July 4, 1914, *Farwell 3651, 3669½, 3720½;* growing in muck lands, on barren hilltops, and in *Sphagnum,* in the order named. SOUTH DAKOTA: Black Hills, *W. S. Rusby.*

The habitat of the variety is as variable as that of the typical form. The plants growing in *Sphagnum* are the smallest but seem to perfect fruit more readily than those in other situations; those growing in rich muck in elder thickets are the largest and do not perfect fruit at all; the plant does not disdain the exposed tops and sides of more or less barren hills but fruit is seldom seen in such localities. With all its variableness, however, the soft velvety pubescence of the plant remains constant.

VAGNERA TRIFOLIA (L.) Morong

This species and *Unifolium bifolium* are locally known as wild lily-of-the-valley. In the Lake Superior region of Michigan both are quite common. Besides the ordinary three-leaved form of *V. trifolia* there are two others that are frequently met with; one has two leaves to the stem, and the other, one leaf. These may be recorded as follows:

Vagnera trifolia bifolia forma nov.

A form with two leaves on the stem.
MICHIGAN: Keweenaw Peninsula, June 16, 1886, *Farwell 378a.*

Vagnera trifolia unifolia forma nov.

A form with only one leaf on the stem.
MICHIGAN: Keweenaw Peninsula, June 16, 1886, *Farwell 378b.*

DEPARTMENT OF BOTANY,
PARKE, DAVIS & COMPANY,
DETROIT, MICHIGAN.

Explanation of plate 20

FIGS. 1–11. UNIFOLIUM BIFOLIUM (L.) Greene

1. Pressburg, Hungary, *Richter*. 2. Woods near Munich, Germany, May, 1891, *C. J. Mayer*. 3. Woods near Munich, Germany, May, 1887, *Loher*. 4. Moheda, Sweden, *C. G. H. Cavassius*. 5. Same locality and collector (forma *monophyllum*). 6. Lyngby, Denmark, June, 1865, *J. Lange*. 7, 8. Black Hills, South Dakota, *W. S. Rusby*. 9, 10. Owosso, Michigan, May 21, 1889, *G. H. Hicks*. 11. Stoney Creek, Michigan, *Farwell 3412*.

FIGS. 12–19. UNIFOLIUM BIFOLIUM CANADENSE (Desf.) Farwell

12–14. Westfield, Massachusetts, May 29, 1873, *H. H. Rusby*. 15. East Greenwich, New York, 1867, *A. Fitch*. 16, 19. Algonac, Michigan, September 13, 1914, *Farwell 3898*. 17, 18. Detroit, Michigan, May 9, 1893, *Farwell 379a*.

FIGS. 20, 21. UNIFOLIUM BIFOLIUM OVALE (Pursh) Farwell

20. Lower leaf; Kewenaw Peninsula, Michigan, June 16, 1886, *Farwell 379*. 21. Root leaf; same locality and collector, October, 1914.

FIGS. 22, 23. UNIFOLIUM BIFOLIUM KAMTSCHATICUM (Gmel.) Piper

22. Lower leaf; Cascades of the Columbia River, Washington, June 3, 1882, *W. N. Suksdorf 23*. Upper leaf; same locality, collector, and date.

FIGS. 1–8, 12–15, 22, and 23 were drawn from specimens in the herbarium of Parke, Davis & Company; the remaining figures, from specimens in the herbarium of the writer. All are reduced one half.

INDEX TO AMERICAN BOTANICAL LITERATURE

1908–1915

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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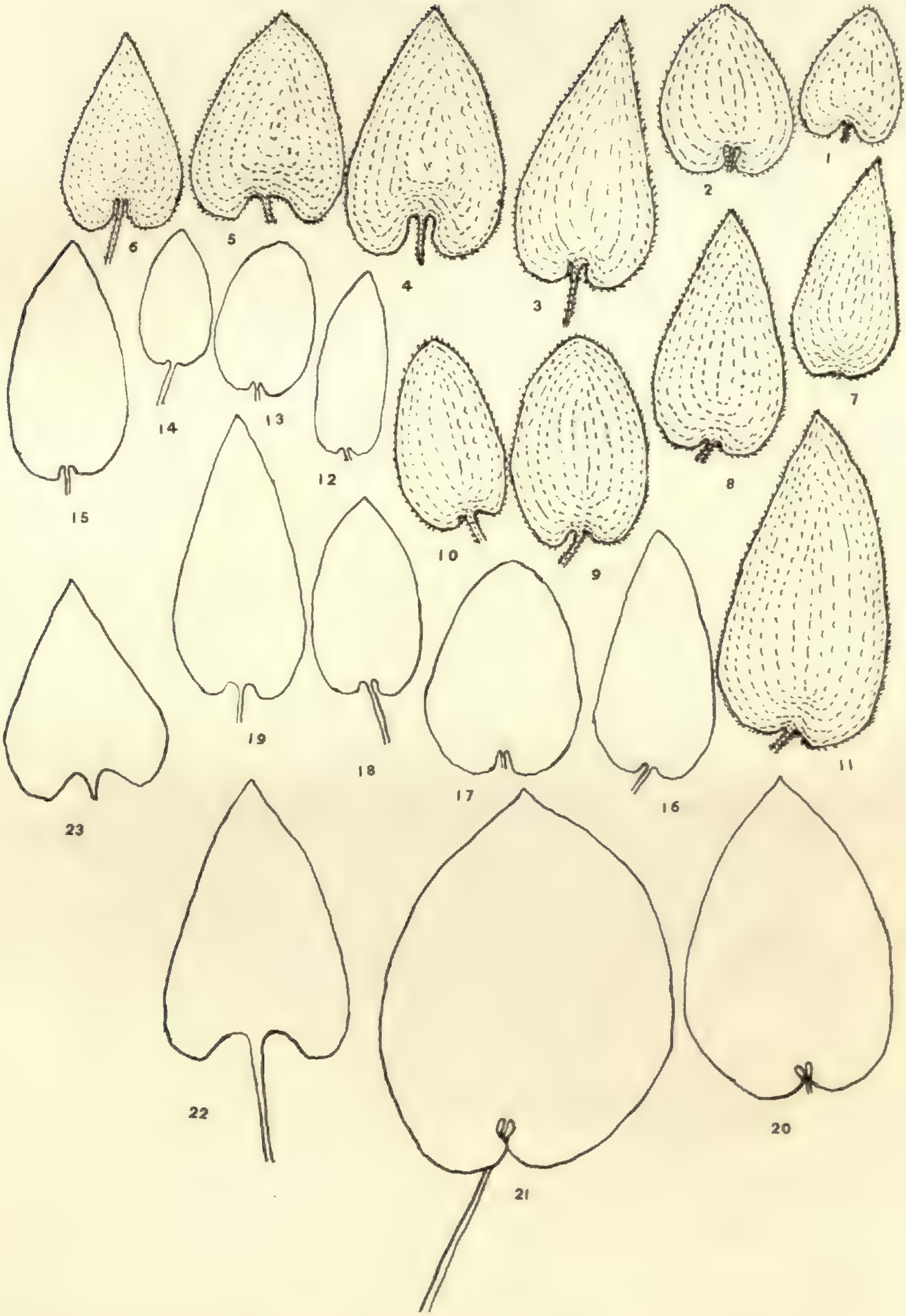
BIHAI HARRISIANA GRIGGS



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BULLETIN

OF THE

TORREY BOTANICAL CLUB

JULY, 1915

Studies of West Indian plants—VI

NATHANIEL LORD BRITTON

35. THE GENUS COCCOLOBIS IN CUBA

A. Leaves 2–13 mm. long; inflorescence one- to three-flowered [RHIGIA].
  Leaves spinulose-mucronate. 1. *C. armata.*
  Leaves emarginate at both ends. 2. *C. microphylla.*
B. Leaves 2 cm. long or longer; inflorescence many-flowered.
  1. Leaves spinulosemucronate.
    Racemes loosely flowered; leaves acute. 3. *C. pilonis.*
    Racemes densely flowered; leaves acuminate. 4. *C. woodfredensis.*
  2. Leaves not spinulose-mucronate.
    Leaves very large, suborbicular, deeply cordate; fruit large; halophytic tree or shrub. 5. *C. Uvifera.*
    Leaves smaller, rarely cordate; fruit small; mesophytes.
      Pedicels filiform, in fruit 8-12 mm. long, as long as the fruit or longer.
        Leaves flat, their margins not revolute. 6. *C. coriacea.*
        Leaves bullate, their margins strongly revolute. 7. *C. Cowellii.*
      Pedicels shorter than the fruit.
        Rachis of the raceme glabrous.
          Leaves almost veinless above, few-veined beneath, rounded, or emarginate. 8. *C. nipensis.*
          Leaves reticulate-veined on both sides.
            Fruiting pedicels 2.5–4 mm. long; fruit 8–12 mm. long. 9. *C. laurifolia.*
            Fruiting pedicels 1.5 mm. long or less; fruit smaller.
              Leaves obtuse or emarginate at apex, obtuse at base. 10. *C. retusa.*
              Leaves acuminate or acute.
                Leaves acuminate at both ends. 11. *C. cubensis.*
                Leaves acute at apex, oblique at base. 12. *C. colomensis.*

[The BULLETIN for June (42: 315–364. *pl. 19, 20*) was issued June 16, 1915.]

Rachis of the raceme puberulent or pubescent (or glabrous in *C. Wrightii* ?).
Raceme stout, 8–20 cm. long; leaves 8–17 cm. long; flowers sessile.
Leaves loosely reticulate-veined; flowers white. 13. *C. costata.*
Leaves densely reticulate-veined; flowers bright red. 14. *C. Shaferi.*
Raceme slender, shorter; leaves smaller.
Leaves not reticulate-veined above.
Raceme geniculate. 15. *C. geniculata.*
Raceme not geniculate.
Fruiting pedicels less than 0.5 mm. long. 16. *C. rufescens.*
Fruiting pedicels 1–2 mm. long.
Leaf-margins reflexed. 17. *C. reflexa.*
Leaf-margins not reflexed. 18. *C. praecox.*
Leaves reticulate-veined above.
Leaves short-acuminate. 19. *C. benitensis.*
Leaves acute or obtuse.
Pedicels 0.8 mm. long or less.
Leaves coriaceous, oblong-lanceolate, 5 cm. long or less. 20. *C. pallida.*
Leaves chartaceous, ovate or elliptic, larger.
Racemes as long as the leaves or longer; petioles 5–10 mm. long. 21. *C. diversifolia.*
Racemes shorter than the leaves; petioles 3 mm. long or less. 22. *C. brevipes.*
Fruiting pedicels 1.5–3 mm. long. 23. *C. Wrightii.*

1. C. ARMATA C. Wright; Griseb. Cat. Pl. Cub. 62, 283. 1866

TYPE LOCALITY: Near San Marco.

DISTRIBUTION: Dry, rocky hills, Oriente, Santa Clara. Endemic.

The plant becomes much larger than the original description indicates; on the Rio San Juan, Santa Clara, it forms a tree 6 m. high, and on the United States Naval Station, Guantanamo Bay, Oriente, trees up to 10 m. high were observed.

2. C. MICROPHYLLA C. Wright; Griseb. Cat. Pl. Cub. 62. 1866

TYPE LOCALITY: Western Cuba.

DISTRIBUTION: Coastal thickets, Santa Clara, Pinar del Rio. Endemic.

At Coloma, Pinar del Rio, forms a virgate tree 5 m. high.

3. C. PILONIS Urban, Repert. **13**: 445. 1914

TYPE LOCALITY: Loma Pilon, near Holguin, Oriente.

DISTRIBUTION: Barren rocky soil, Oriente, Santa Clara (?). Endemic.

The Santa Clara specimens, collected near the city of Santa Clara (*Britton & Wilson 6189*, *Britton & Cowell 13325*), are in foliage only and thus not determinable with certainty.

Both this species and the following one are related to *C. flavescens* Jacq., of Hispaniola. The type is from a shrub 1.6 m. high.

4. **Coccolobis woodfredensis** sp. nov.

Similar to *C. pilonis*, and to *C. flavescens* Jacq. (of Hispaniola), the leaves spinulose-mucronate. A shrub, 6 m. high, glabrous throughout, the rather stout branches zig-zag; leaves coriaceous, ovate to ovate-lanceolate, 3–6 cm. long, shining above, dull beneath, inconspicuously veined, the under surface very finely reticulated, the apex spinulose-mucronate, the base rounded, obtuse or subcordate, the stout petioles scarcely 2 mm. long; racemes very narrow, 3–4 cm. long, densely many-flowered; fruiting pedicels about 1 mm. long; old fruit ovoid, acutish, 4 mm. long, 2 mm. thick.

Dry rocky hillside, between Piedra Gorda and Woodfred, Sierra Nipe, Oriente, 400–500 m. alt. (*Shafer 3180*).

5. C. UVIFERA (L.) Jacq. Enum. 19. 1760

TYPE LOCALITY: Shores of the Caribbean Sea.

DISTRIBUTION: Coastal thickets, all provinces and Isle of Pines; occasionally on hillsides back from the coasts: Florida; West Indies; continental tropical America.

6. C. CORIACEA A. Rich. in Sagra, Hist. Cub. **11**: 184. 1850

C. calobotrys Meisn. in DC. Prodr. **14**: 157. 1857.

TYPE LOCALITY: Vuelta de Abajo, Cuba.

DISTRIBUTION: Pinar del Rio (?), Havana, mountains of Oriente. Endemic.

Meisner cites Sagra's Nos. 290 and 544, on which he based *C. calobotrys*, from the vicinity of Havana, but the plant is not known to grow in Havana Province. I have not seen the type specimens. A specimen from Ensenada de Mora, Oriente (*Britton, Cowell & Shafer 13003*), is from a slender tree 7 m. high.

7. **Coccolobis Cowellii** sp. nov.

A glabrous shrub, 1.5 m. high, with few, stout, ascending branches. Leaves thick-coriaceous, shining, deeply cordate at the nearly sessile base, bullate, with strongly revolute margins, diversiform, some ovate to ovate-elliptic, 5–9 cm. long, rounded at the apex, some elongated-lanceolate, attenuate-acuminate, 10–18 cm. long; principal venation impressed above, prominent beneath; ultimate venation obscure on both surfaces; racemes terminal, nearly sessile, 1–3 dm. long, the rachis and pedicels glabrous; pedicels filiform, 3–6 mm. long, spreading; bracts scarcely 1 mm. long, ovate, acute, about as long as the nearly truncate ochreolae; flowers bright red, 3 mm. long; perianth-lobes oblong, obtuse; fruit ovoid, acute, 4 mm. long, crowned by the calyx-lobes.

Barren rocky soil, savannas near Camaguey (*Britton & Cowell 13151*).

8. C. NIPENSIS Urban, Repert. **13**: 445. 1914

TYPE LOCALITY: Pine lands, 500–650 m. alt., Sierra Nipe, near Woodfred, Oriente.

DISTRIBUTION: Mountains of northern Oriente. Endemic.

This species is noted by Dr. Shafer as forming a tree up to 10 m. high.

9. C. LAURIFOLIA Jacq. Hort. Schoen. 3: 9. *pl. 267*. 1798

C. floridana Meisn. in DC. Prodr. **14**: 165. 1857.

TYPE LOCALITY: Caracas.

DISTRIBUTION: Thickets and woodlands at lower elevations near the coasts, Oriente, Camaguey, Matanzas, Isle of Pines: Florida; Bahamas; Jamaica; Hispaniola to St. Croix; Venezuela.

10. C. RETUSA Griseb. Cat. Pl. Cub. 61. 1866

C. leoganensis parvifolia Griseb. Cat. Pl. Cub. 61. 1866. Hyponym.

TYPE LOCALITY: Eastern Cuba.

DISTRIBUTION: Thickets and hillsides, Oriente, Santa Clara, Pinar del Rio: Hispaniola (?).

11. C. CUBENSIS Meisn. in DC. Prodr. 14: 162. 1857

TYPE LOCALITY: Cuba [near Santiago].

DISTRIBUTION: Oriente. Endemic.

Dr. Shafer's *4229*, from rich woods in the alluvial valley of Rio Yamaniguey, northern Oriente, referred to this species from description, is from a tree 5 m. high.

12. **Coccolobis colomensis** sp. nov.

A glabrous shrub, 2 m. high, with slender twigs. Leaves chartaceous, ovate to elliptic, 4–10 cm. long, bluntly acute at the apex, obliquely obtuse at the base, strongly reticulate-veined and shining on both sides, the rather stout petioles 6–10 mm. long; racemes glabrous, terminal, nodding, much shorter than the leaves, 5 cm. long or less; ochreolae less than 0.5 mm. long; pedicels about 1.5 mm. long, spreading; flowers about 1 mm. long, the ovate perianth-lobes as long as the tube; anthers not exserted; young fruit ovoid, about 3.5 mm. long, short-coronate.

Marsh near Coloma, Pinar del Rio (*Britton & Gager 7037*).

13. C. COSTATA C. Wright; Sauvalle, Anales Acad. Habana 7: 343. 1870

C. leoganensis cordata Griseb. Cat. Pl. Cub. 61. 1866. Hyponym.

TYPE LOCALITY: Cuba [*C. Wright 1393*, eastern Cuba].

DISTRIBUTION: Mountains of Oriente; Porto Rico.

Dr. Shafer's *3084*, which satisfactorily matches *Wright 1393*, is from a tree 8 m. high, at 400–500 m. alt. on the Sierra Nipe, in dry rocky thickets; he noted the flowers as white and the fruit red-black.

14. **Coccolobis Shaferi** sp. nov.

A shrub or small tree up to 4 m. high, the twigs and leaves glabrous. Leaves coriaceous, ovate or ovate-elliptic to lanceolate, 12 cm. long or less, strongly and rather densely reticulate-veined on both sides, obtuse, acute or acuminate at the apex, cordate at the base, the stout petioles about 1 cm. long; spikes dense,

slender, 6–12 cm. long, the rachis, bracts and ochreolae puberulent; flowers bright red, sessile, about 5 long, the short perianth-lobes rounded.

Hillsides and thickets, northern Oriente.

Type, *Shafer 4165*, from between Camp Toa and Camp La Barga, 400–450 m. alt.

15. C. GENICULATA Lindau, Bot. Jahrb. 13: 141. 1891

TYPE LOCALITY: Near Puerto Principe, Cuba.

DISTRIBUTION: Known only from the type locality.

Referred by Grisebach to *C. punctata parvifolia* Griseb.

16. C. RUFESCENS C. Wright; Sauvalle, Anales Acad. Habana 7: 343. 1870

C. punctata parvifolia Griseb. Mem. Am. Acad. II. 8: 175. 1860.

C. rufescens longifolia Lindau, Bot. Jahrb. 13: 143. 1891.

TYPE LOCALITY: Cuba.

DISTRIBUTION: Mountains of Oriente. Endemic.

17. C. REFLEXA Lindau, Bot. Jahrb. 13: 141. 1891

TYPE LOCALITY: Cuba [*Wright 2256*].

DISTRIBUTION: *Britton & Cowell 13115*, from a tree 6 m. high, in savannas near Camaguey, appears to be the same as *Wright 2256*.

18. C. PRAECOX C. Wright; Lindau, Bot. Jahrb. 13: 142. 1891

TYPE LOCALITY: Cuba.

DISTRIBUTION: Known only from the type specimens (*Wright 2253*).

19. **Coccolobis benitensis** sp. nov.

A much-branched shrub, up to 2 m. high, the twigs more or less tortuous, glabrous. Leaves coriaceous, ovate, or elliptic-ovate, 1.5–7 cm. long, glabrous, punctate, short-acuminate at the apex, rounded or obtuse at the base, densely prominently reticulate-veined on both sides, the primary veins prominent beneath, the petioles 1.5–4.5 mm. long; spike-like racemes very slender, short-stalked, 4 cm. long or less, the ochreae and rachis puberulent; flowering pedicels scarcely longer than the ochreolae, 0.5 mm. long or less; fruiting pedicels 1–1.5 mm. long; perianth (young) about

0.5 mm. long; fruit ovate-ellipsoid, 5–6 mm. long, about 3 mm. thick, dark red.

Wet mountains of northern Oriente. Type from vicinity of Camp San Benito, 900 m. alt. (*Shafer 4049*).

20. C. PALLIDA C. Wright; Griseb. Cat. Pl. Cub. 61. 1866

TYPE LOCALITY: Western Cuba, near San Marco.

DISTRIBUTION: Known only from the type locality [*Wright 2254*].

21. C. DIVERSIFOLIA Jacq. Enum. 19. 1760

TYPE LOCALITY: Caribbean Islands.

DISTRIBUTION: Cuba, collected by Read, according to Lindau: Bahamas; Jamaica; Hispaniola; Porto Rico; Vieques; St. Thomas; St. Jan; St. Croix; Saba; Anguilla (?); Antigua; Montserrat; Guadeloupe; Dominica; Martinique; St. Lucia; Barbadoes; Bonaire; Curaçao; Aruba. Planted in Bermuda.

22. **Coccolobis brevipes** sp. nov.

Twigs slender, densely puberulent. Leaves chartaceous, elliptic, 3–7 cm. long, bluntly acute at the apex, obliquely narrowed or rounded at the base, shining above, glaucescent beneath, glabrous and strongly reticulate-veined on both sides, the principal veins prominent beneath; petioles stout, 2–3 mm. long; racemes terminal, about 5 cm. long, densely puberulent; bracts puberulent, acute, scarcely 1 mm. long; ochreolae about as long as the bracts; flowering pedicels 0.5–0.8 mm. long; flowers about 1.5 mm. long, the perianth-lobes ovate.

Cuba (*Wright 2257* in herbarium of the Missouri Botanical Garden). Lindau, in Bot. Jahrb. **13**: 152, cites this number as part of *C. Wrightii* Lindau, but the specimen here described is different from *Wright 1395*, the type of *C. Wrightii*.

C. brevipes is similar to *C. rufescens* C. Wright in leaf-form and pubescence, but the venation is quite different.

23. C. WRIGHTII Lindau, Bot. Jahrb. **13**: 151. 1891

TYPE LOCALITY: Near Monte Verde, Oriente.

DISTRIBUTION: Mountains of northern Oriente.

Referred by Grisebach to *C. tenuifolia* L.

36. ADDITIONAL SPECIES OF TABEBUIA GOMEZ

The type species is *Bignonia Tabebuya* Vell., of Brazil, a species with simple leaves. It is not possible to separate the group into two genera, the one with simple, the other with compound leaves, as has been proposed by several authors,* calling the compound-leaved species Tecomas, and the true type of *Tecoma* Juss. is *Bignonia stans* L. (*Tecoma stans* HBK., *Stenolobium stans* Seem.). The two-lipped calyx of the type species of *Tabebuia* is not constant through the group.

Tabebuia Brooksiana sp. nov.

A tree, up to 30 m. high. Leaves 4–7-foliolate; petioles 12 cm. long or less; petioles slender, 1–4 cm. long; leaflets oblong, oblong-lanceolate or oblong-oblanceolate, chartaceous, 5–12 cm. long, 4 cm. wide or less, faintly shining above with the veins impressed, dull, mostly finely reticulate-veined when mature, and lepidote beneath, with the midvein and lateral veins prominent, obtuse, acute or retuse at the apex, the base obtuse or acutish; flowers clustered; calyx 2-lipped, 10–15 mm. long; corolla pink, 5–6 cm. long, the tube about 5 mm. long, the narrowly campanulate throat about 3.5 cm. long, the limb about 1.5 cm. long, its undulate lobes ciliolate.

Woodlands, provinces of Oriente and Camaguey, Cuba, from sea-level up to 350 m. altitude. Type from Ensenada de Mora, Oriente (*Britton, Cowell & Shafer 12985*). Referred by Grisebach to *Tecoma Leucoxylon* Mart. and to *T. Leucoxylon reticularis* Griseb. The species is named in honor of Mr. Theodore Brooks of Guantanamo, who has rendered important aid to scientific exploration. *Tecoma heptaphylla* A. Rich. in Sagra, Hist. Cub. 11: 106 (not Martius), described as with 7-foliolate leaves from Vuelta de Abajo (Pinar del Rio), Cuba, is not known to me; I have seen no species with 7-foliolate leaves from western Cuba.

Tabebuia Shaferi sp. nov.

A tree, up to 10 m. high. Larger leaves 6–8-foliolate; petioles 3–4 cm. long; petiolules 2 cm. long or less; leaflets ovate-oblong to suborbicular, chartaceous, the larger 6 cm. long, 3–5 cm. wide, dark green above, paler beneath, minutely and densely reticulated

* See Urban, Symb. Ant. 7: 377.

on both sides, the midvein impressed above, prominent beneath, the apex rounded or obtuse, the base subcordate; "flowers pinkish"; capsule 12 cm. long; seeds 5 mm. long, 7 mm. wide, the wings 5 mm. wide.

Along a small stream in the Pinales southeast of Paso Estancia, Oriente, Cuba (*Shafer 1710a*). Apparently the same as *C. Wright 3043*, referred by Grisebach to *Tecoma Leucoxylon* Mart., *forma foliolis latioribus*.

Tabebuia pachyphylla sp. nov.

A tree, up to 12 m. high. Petioles stout, 6–8 cm. long; petiololes stout, 4 cm. long or less; leaflets 5–7, oblong to ovate-oblong, coriaceous, 5–12 cm. long, 2.5–6 cm. wide, lustrous above, dull and densely minutely reticulate-veined beneath, the midvein prominent, the lateral veins slender, the apex bluntly acute, the base rounded or subcordate; flowers pink, clustered; calyx 15 mm. long, bluntly lobed; corolla pink, glabrous, about 5 cm. long, its narrow throat about twice as long as the limb, its lobes rounded.

Mountains of northeastern Cuba. Type specimen collected at Arroyo del Medio, Sierra Nipe, Oriente, Cuba, 450–550 m. alt. (*Shafer 3645*).

Tabebuia trinitensis sp. nov.

A tree up to 10 m. high. Leaves 4-foliolate or 5-foliolate; petioles slender, 8–11 cm. long; petiolules slender, 4 cm. long or less; leaflets thin-chartaceous, oblong or oblong-lanceolate, dark green above, paler and lepidote beneath, the larger ones 11–15 cm. long, 3–4 cm. wide, bluntly acute or acuminate at the apex, obtuse at the base, finely reticulate-veined and the primary venation rather prominent on both sides.

Hanabanilla Falls, Trinidad Mountains, province of Santa Clara, Cuba (*Britton, Earle & Wilson 4866*).

The description is from leaf-specimens only but these indicate that the tree is a species distinct from all others of Cuba. The ultimate venation and texture of the leaflets differentiate it from *T. Brooksiana* Britton.

Tabebuia calcicola sp. nov.

A slender tree, up to 6 m. high. Leaves 2–5-foliolate; petioles stout, lepidote, 4–5 cm. long; petiolules lepidote, 1.5 cm. long or less; leaflets coriaceous, light green, ovate to ovate-oblong, 3.5–8

cm. long, 5 cm. wide or less, acute or bluntish at the apex, rounded at the base, finely reticulate veined and densely lepidote on both sides, the primary venation impressed above, prominent beneath; flowers clustered; pedicels stout; calyx 12–14 mm. long, shortly 2-lipped; corolla about 5 cm. long, the tube about 5 mm. long, the campanulate white throat 3 cm. long, the pink limb about 1.5 cm. long, the undulate lobes ciliolate; capsule 10–14 cm. long.

Limestone rocks and cliffs, province of Pinar del Rio, Cuba. Type collected near Guane (*Britton & Cowell 9772*).

Tabebuia moaensis sp. nov.

A shrub, about 1 m. high. Leaves 3–5-foliolate; petioles stout, 2 cm. long or less; petiolules rather stout, 4–15 mm. long; leaflets elliptic to obovate, coriaceous, 3–5 cm. long, 1–2 cm. wide, lustrous above, dull and minutely reticulate-veined beneath, the primary venation not very prominent; calyx 10 mm. long, 2-lipped; corolla pink, about 4 cm. long, its rounded lobes ciliolate.

Camp La Gloria, south of Sierra Moa, Oriente, Cuba (*Shafer 8264*). This is, apparently, the same as *C. Wright 3047*, referred by Grisebach to *Tecoma haemantha*.

Tabebuia pinetorum sp. nov.

A shrub, about 2.6 m. high. Leaves 3-foliolate or 4-foliolate; petioles very stout, only 3 cm. long or less, petiolules stout, 3–8 mm. long; leaflets elliptic or ovate-elliptic, coriaceous, 5–14 cm. long, 2.5–8 cm. wide, shining above, obtuse, rounded or bluntly short-pointed at the apex, obliquely cordate at the base, dull, lepidote and finely reticulate-veined beneath, the primary venation impressed above, prominent beneath; peduncles stout; calyx 12 mm. long, somewhat 2-lipped; "flowers lilac"; pod 11 cm. long, about 1 cm. thick.

Pine woods, Baracoa, Oriente, Cuba (*Underwood & Earle 1362*).

Tabebuia arimaoensis sp. nov.

A small tree with slender, whitish twigs. Leaves 3-foliolate; petioles slender, 1–2.5 cm. long; leaflets subcoriaceous, shining above, with the midvein impressed dull beneath with the midvein prominent, lepidote on both sides, acute, the terminal one with a petiolule 2–5 mm. long, cuneate-oblanceolate, 4–5 cm. long, 8–12 mm. wide, the lateral ones sessile, narrowly oblong, inequilateral, obliquely narrowed at the base. Flowers and fruit unknown.

Rocky hillside, Rio Arimao, province of Santa Clara, Cuba (*Britton & Wilson 5797*).

Tabebuia arenicola sp. nov.

A tree 7 m. high. Leaves 3-foliolate; petioles slender, 1–2.5 cm. long; leaflets subcoriaceous, shining, sparingly lepidote, and obscurely veined above, dull, closely lepidote and with prominent midvein and slender lateral veins beneath, inconspicuously reticulate-veined, obtuse or emarginate at the apex, the terminal one oblanceolate, 6–7 cm. long, 1.2–2 cm. wide, acute at the base, with a petiolule 4–6 mm. long, the lateral ones oblong, 4–6 cm. long, sessile by a very oblique base.

Sandy plain, Conde Beach, Guantanamo Bay, Oriente, Cuba (*Britton 2142*).

Tabebuia geronensis sp. nov.

Twigs stout. Leaves 1–3-foliolate; petioles slender, 1 cm. long or less; in 3-foliolate leaves, the lateral leaflets sessile, the terminal one short-stalked; leaflets oblong to ovate-elliptic or ovate-oblong, subcoriaceous, 3.5–7 cm. long, 3 cm. wide or less, obtuse and rounded or apiculate at the apex, rounded, subcordate, or lateral ones obliquely narrowed at the base, dull on both sides, lepidote above, finely and strongly reticulate-veined and densely lepidote beneath; fruiting calyx densely lepidote, 1 cm. long; capsule 8–9 cm. long, about 8 mm. thick, with a slender tip 6 mm. long.

Nueva Gerona, Isle of Pines, Cuba (*A. H. Curtiss*, May, 1904).

Tabebuia Curtissii sp. nov.

Young twigs, leaves, pedicels and calyx densely lepidote-scurfy. Leaves 3-foliolate, or the upper and lower 1-foliolate; leaflets coriaceous, those of 1-foliolate leaves elliptic, 3–6 cm. long, obtuse at both ends, those of 3-foliolate leaves obovate or oblong-obovate, 8 cm. long or less, abruptly acute at the apex, narrowed at the base, the terminal one short-stalked, the lateral ones sessile, all smooth and shining above, dull, reticulate-veined and densely lepidote beneath; flowers in terminal clusters; pedicels 2 cm. long or less; calyx narrowly campanulate, 1.5 cm. long, its teeth triangular, acute; corolla 5 cm. long, its lobes broad and rounded.

Nueva Gerona, Isle of Pines, Cuba (*A. H. Curtiss*, May, 1904).

Tabebuia crassifolia sp. nov.

A tree, 5 m. high. Leaves simple, oblong-elliptic, coriaceous, 6–12 cm. long, 4.5 cm. wide or less, obtuse or emarginate at the apex, somewhat narrowed at the base, when young densely lepidote and dark green above, pale and more densely lepidote beneath; when old strongly shining, elepidote and with impressed midvein above, remaining densely lustrous-lepidote and with very prominent midvein beneath, the secondary venation slender, neither surface reticulate-veined, the stout lepidote petioles 10–14 mm. long; flower solitary in an upper axil, its slender peduncle 3 cm. long, bearing a linear bractlet 2 mm. long below the middle; calyx densely lepidote, 1 cm. long, lobed but scarcely two-lipped; corolla light purple, about 5 cm. long.

By a spring, barren savannas southeast of Holguin, Oriente, Cuba (*Shafer 1285*).

Tabebuia angustata sp. nov.

A tree up to 12 m. high. Leaflets 3–7-foliolate; petioles slender, 5–13 cm. long; petiolules slender, 5 cm. long or less; leaflets chartaceous, oblong or oblong-lanceolate, 5–18 cm. long, 9 cm. wide or less; dull on both sides, more or less lepidote, at least when young, densely and finely reticulate-veined beneath with a prominent midvein and slender lateral veins, the apex bluntly acuminate or acute, the base obtuse or acute; flowers clustered; calyx 2-lipped, 12–16 mm. long; corolla rosy-white, 5–6 cm. long, its narrow throat somewhat longer than the limb, its lobes ciliate; capsule 10–25 cm. long.

Woodlands and along streams at lower and middle elevations in wet or moist parts of Jamaica. Type collected on the southwestern slope of Dolphin Head (*Harris 9253*). This tree has been referred to *Tecoma platyantha* Griseb.

Tabebuia jamaicensis sp. nov.

A tree up to 12 m. high. Leaves 5-foliolate; petioles stout, 15 cm. long; petiolules stout, 2–9 cm. long; leaflets chartaceous, the three upper obovate, 18–23 cm. long, 9–12 cm. wide, somewhat narrowed at the base, the two lower ovate-elliptic, about 10 cm. long and 6 cm. wide, rounded or subtruncate at the base, all abruptly acuminate at the apex, finely reticulate-veined and loosely lepidote on both sides, the midvein and lateral veins prominent beneath; corolla whitish, glabrous, 5 cm. long, its cylindric tube about 8 mm. long, its campanulate throat 2.5 cm. long, its spreading limb about 1.5 cm. long, its lobes erose.

Hillside, Negril, Jamaica (*Britton 2020*). The description is based on one leaf and one flower.

Tabebuia actinophylla (Griseb.)

Tecoma actinophylla Griseb. Cat. Pl. Cub. 194. 1866.

TYPE LOCALITY: Western Cuba.

DISTRIBUTION: Limestone cliffs, province of Pinar del Rio, Cuba.

Tabebuia Sauvallei nom. nov.

Tecoma sanguinea C. Wright; Sauvalle, Anales Acad. Habana **6**: 320. 1870. Not *Tabebuia sanguinea* DC.

TYPE LOCALITY: Border of Rio Carbuni, Manacal, near Trinidad, Cuba.

DISTRIBUTION: Hillsides and river banks, near Trinidad, province of Santa Clara, Cuba.

Tabebuia Buchii (Urban)

Tecoma Buchii Urban, Symb. Ant. **3**: 375. 1903.

Known only from the type locality, dry calcareous mountains, Morne La Pierre, Haiti.

Tabebuia lepidota (HBK.)

Bignonia lepidota HBK. Nov. Gen. **3**: 139. 1818.

Tecoma lepidota DC. Prodr. **9**: 220. 1844.

TYPE LOCALITY: Havana, Cuba.

DISTRIBUTION: Barren soil, provinces of Camaguey, Santa Clara, Matanzas and Havana, Cuba; Bahamas.

Referred by Grisebach to *Tecoma lepidophylla* and to *Tecoma Leucoxylon* and by Combs to *Tabebuia lepidophylla*.

The species consists, apparently, of many races, differing in size, number and form of leaflets and size of flowers.

Tabebuia Berterii (DC.)

Tecoma Berterii DC. Prodr. **9**: 220. 1845.

TYPE LOCALITY: Santo Domingo.

DISTRIBUTION: Hispaniola, ascending to 1,200 m. altitude.

Tabebuia domingensis (Urban)

Tecoma domingensis Urban, Symb. Ant. 7: 376. 1912.

TYPE LOCALITY: Near Barahona, Santo Domingo.

DISTRIBUTION: Known only from the type locality.

Tabebuia revoluta (Urban)

Tecoma revoluta Urban, Symb. Ant. 7: 539. 1913.

TYPE LOCALITY: Between La Vega and Jarabacoa, Santo Domingo, at 700 m. alt.

DISTRIBUTION: Known only from the type locality.

Tabebuia acrophylla (Urban)

Tecoma acrophylla Urban, Symb. Ant. 3: 374. 1903.

TYPE LOCALITY: Mountains near Bilboro, Haiti, at 600 m. alt.

DISTRIBUTION: Known only from the type locality.

Tabebuia bibracteolata (Griseb.)

Tecoma bibracteolata Griseb. Cat. Pl. Cub. 193. 1866.

TYPE LOCALITY: Eastern Cuba.

DISTRIBUTION: Known only from the type specimens.

TABEBUIA HETEROPHYLLA (DC.) Britton, Ann. Mo. Bot. Gard. 2: 48. 1915

Rapuntia (?) *heterophylla* DC. Mém. Mus. Paris 9: 153. 1822.
Tabebuia triphylla DC. Prodr. 9: 214. 1845. Not *Bignonia triphylla* L.

Sandy soil and rocky hillsides, Mona, Porto Rico, Vieques, Culebra, St. Thomas, St. Croix, St. Jan, Virgin Gorda, Anagada; recorded from St. Barts and Barbadoes.

Referred by Grisebach to *Tecoma Berterii* DC., and by Urban to *Tecoma Leucoxylon* (L.) Mart.; this is not *Tabebuia leucoxyla* DC. Prodr. 9: 212.

Tabebuia myrtifolia (Griseb.)

Tecoma myrtifolia Griseb. Mem. Am. Acad. II. 8: 524. 1862.
Tecoma lepidota myrtifolia Maza, Anal. Hist. Nat. Madrid 19: 265. 1890.

? *Bignonia microphylla* A. Rich. in Sagra, Hist. Cub. **11**: 104. 1850. Not Lam.

TYPE LOCALITY: Matanzas, Cuba.

DISTRIBUTION: Coastal thickets, vicinity of Matanzas, Cuba.

Tabebuia platyantha (Griseb.)

Tecoma platyantha Griseb. Fl. Br. W. I. 447. 1864.

Tecoma Brittonii Urban, Symb. Ant. **5**: 496. 1908.

Tecoma Brittonii decussata Urban, loc. cit. 497. 1908.

TYPE LOCALITY: On rocks, St. James, Jamaica.

DISTRIBUTION: Rocky woodlands, central parishes of Jamaica.

Tabebuia bahamensis (Northrop)

Bignonia pentaphylla L. Sp. Pl., ed. 2, 870. 1763 (as to the Bahama plant of Catesby). Not *Tabebuia pentaphylla* (Juss.) Hemsl.

Tecoma bahamensis Northrop, Mem. Torr. Club **12**: 65. *pl. 15.* 1902.

TYPE LOCALITY: Near Nassau, New Providence, Bahamas.

DISTRIBUTION: Bahamas; Cuba.

37. THE GENUS ANASTRAPHIA D. Don

Type species: *Anastraphia ilicifolia* D. Don.

Founded on a specimen in the Lambertian Herbarium said to have come from South America; the plant was correctly attributed to Cuba by De Candolle (Prodr. **7**: 26. 1838).

1. **Involucral bracts straight, erect or nearly so.**
   Involucre 2.5–3 cm. long.
      At least some of the leaves spinulose-dentate.
         Involucre campanulate.
            All the involucral bracts lanate. — 1. ***A. ilicifolia.***
            Only the outer bracts lanate, the inner glabrous.
               Leaves distinctly reticulate-veined above.
                  All the involucral bracts linear-lanceolate, acuminate and erect. — *2. A. manluensis.*
                  Outer involucral bracts lanceolate, merely acute, all somewhat spreading. — *3. A. montana.*
               Leaves very indistinctly reticulate-veined above, but wrinkled; outer bracts ovate. — *4. A. Cowellii.*
         Involucre long-attenuate at base, all its many bracts lanate. — *5. A. attenuata.*

None of the leaves spinulose-dentate.
Involucral bracts tomentose. — 6. *A. Picardae.*
Inner involucral bracts glabrous. — 7. *A. crassifolia.*
Involucre 2 cm. long or less.
Involucre 1.5–2 cm. long.
Leaves or some of them 1.5–2 cm. long.
Inner involucral bracts obtusish or short-pointed. — 8. *A. oligantha.*
Inner involucral bracts acuminate. — 9. *A. bahamensis.*
Leaves 12 mm. long or less.
Leaves strongly spinulose-dentate. — 10. *A. calcicola.*
Leaves repand-denticulate. — 11. *A. parvifolia.*
Involucre 1.5 cm. long or less.
Leaves 2–3 times as long as wide.
Leaves spinulose-denticulate.
Leaves strongly reticulated beneath. — 12. *A. Wilsoni.*
Leaves not reticulated beneath, or faintly reticulated.
Achenes short-tomentose; leaves reticulate-veined above. — 13. *A. intertexta.*
Achenes villous; leaves smooth above. — 14. *A. Shaferi.*
Leaves entire-margined. — 15. *A. obtusifolia.*
Leaves not longer than wide, or but little longer.
Leaves obtuse or truncate at base.
Involucre 6 mm. long. — 16. *A. microcephala.*
Involucre 10 mm. long. — 17. *A. Rosei.*
Leaves cuneate at base. — 18. *A. Buchii.*
2. Involucral bracts recurved, or with recurved tips.
Involucral bracts arachnoid. — 19. *A. Northropiana.*
Involucral bracts villous. — 20. *A. recurva.*
3. Involucre known only in a young condition; leaves oblong, 4 cm. long, 1.8 cm. wide, entire-margined or with a tooth near the apex. — 21. *A. lomensis.*

1. ANASTRAPHIA ILICIFOLIA D. Don, Trans. Linn. Soc. **16**: 296. 1830

Gochnatia ilicifolia Less. Linnaea **5**: 261. 1830 (attributed to Guiana doubtfully).

TYPE LOCALITY: South America [in error].

DISTRIBUTION: Limestone cliffs and river-gorges, provinces of Matanzas and Havana, Cuba. A shrub 2–3 m. high, the leaves shining above.

A specimen in Kew Herbarium from rocks on the Rio Canimar, Cuba, 1823, bears the label *Staehelina ilicifolia* Mutis., but that species is a South American *Gynoxys*.

2. ANASTRAPHIA MANTUENSIS C. Wright; Griseb. Cat. Pl. Cub. 158. 1866

TYPE LOCALITY: Pine lands near Mantua, Cuba.

DISTRIBUTION: Pine lands and rocky hillsides, near Mantua, Province of Pinar del Rio, Cuba.

3. **Anastraphia montana** sp. nov.

A depressed, spreading or prostrate shrub, the young twigs white-floccose. Leaves oblong, or oblong-oblanceolate, 2–4 cm. long, 8–16 mm. wide, coriaceous, sharply spinulose-dentate all around, dark green, shining and densely reticulate-veined above, white-floccose beneath, obtuse or acutish at the apex, the floccose petioles 1–2 mm. long; heads solitary at the ends of branches; involucre campanulate about 2.5 cm. high, its bracts rigid, somewhat spreading, in about 8 series, the outer ovate to lanceolate, slightly lanate, acute, the inner linear-lanceolate, acuminate glabrous achenes linear, narrowed at base, densely appressed-pubescent, 6 mm. long; pappus light brown, spreading, about twice as long as the achene.

Top of Sierra Caliente, south of Sumidero, Pinar del Rio, Cuba, August, 1912 (*Shafer 13781*).

4. **Anastraphia Cowellii** sp. nov.

A shrub, 2 m. high, the young twigs lanate-puberulent. Leaves oblong, 1.5–3.5 cm. long, 6–15 mm. wide, coriaceous, sharply spinulose-dentate, green, glabrous, shining and indistinctly veined, but wrinkled above, brownish-floccose beneath, mostly obtuse at the apex, obtuse or narrowed at the base, the petioles 1–4 mm. long; heads solitary or rarely 2 together; involucre narrowly campanulate, about 3 cm high, its bracts in 7 or 8 series, the outermost ovate, lanate, the middle ones lanceolate, the inner linear-lanceolate, acuminate, glabrous; corollas orange, 2 cm. long; achenes linear, 6–7 mm long, densely pubescent; pappus brownish, spreading, about 3 times as long as the achene.

Rocky hills, palm barren, city of Santa Clara, Cuba (*Britton & Cowell, 10183, type*); same locality (*Britton & Wilson 6073*); rocky places in savanna, Queen City to Minas, Camaguey, Cuba (*Shafer 2927*); savanna near Camaguey (*Britton & Cowell 13248*).

5. **Anastraphia attenuata** sp. nov.

A shrub about 2.5 cm. high, the young twigs densely lanate. Leaves oblong to oblanceolate, 1.5–5 cm. long, 8–17 mm. wide,

coriaceous, entire or some of them remotely spinulose-dentate, green, glabrous and reticulate-veined above, whitish-lanate beneath, obtuse or acute at the apex, narrowed at the base, the petioles 1–2.5 mm. long; heads solitary at the ends of branches; involucre obconic, long-attenuate at the base, 3–3.5 cm. long, its bracts lanate, imbricated in about 14 series, the lower ovate, the upper lanceolate; corolla yellow, about 1 cm. long; achenes linear, densely pubescent, 6 mm. long; pappus tawny, a little longer than the achene.

Moist thickets, Sierra Nipe, Oriente, Cuba, between Piedra Gorda and Woodfred, at 400–500 meters elevation (*Shafer 3113*).

6. ANASTRAPHIA PICARDAE Urban, Symb. Ant. 3: 414. 1903

TYPE LOCALITY: Near Cadets, Haiti, at 1200 m. alt.

DISTRIBUTION: Known only from the type locality.

7. **Anastraphia crassifolia** sp. nov.

A shrub about 1.6 m. high, the young twigs densely tomentose. Leaves oblong, or oblong-oblanceolate, coriaceous, 4–7 cm. long, 1–2 cm. wide, entire-margined, green, shining, and with impressed veins above, lanate-tomentose and with prominent veins beneath; involucre campanulate, nearly 3 cm. high, its bracts in 7 or 8 series, the outer ovate, lanate, the inner linear-lanceolate, glabrous, long-attenuate.

Near mangroves, mouth of Rio Yamaniguey, Oriente, Cuba (*Shafer 4261*). Only one old involucre was collected.

8. ANASTRAPHIA OLIGANTHA Urban, Symb. Ant. 3: 417. 1903

TYPE LOCALITY: Santo Domingo.

DISTRIBUTION: Santo Domingo. Known only from the type specimens collected by Wright, Parry and Brummell in 1871, and from *plate 123, f. 2*, of Plumier, with which they were identified by Professor Urban. Referred to by Hitchcock (Rep. Mo. Bot. Gard. 4: 102) as *A. paucifloscula* C. Wright, an unpublished species.

9. ANASTRAPHIA BAHAMENSIS Urban, Symb. Ant. 3: 415. 1903

Anastraphia paucifloscula Hitchc. Rep. Mo. Bot. Gard. 4: 102. *pl. 12.* 1893. Hyponym.

Anastraphia cuneifolia Greenm. Bull. N. Y. Bot. Gard. 4: 126. 1905.

TYPE LOCALITY: Andros Island, Bahamas.

DISTRIBUTION: Andros, Eleuthera, Cat Island, Fortune Island, Crooked Island, Acklin's Island, Great Exuma, Caicos Islands, Mariguana, Dellis Cay, Inagua.

I cannot distinguish, specifically, from this species, a plant of the Sierra Nipe, Oriente, Cuba (*Shafer 3185*).

10. **Anastraphia calcicola** sp. nov.

A shrub, 1–1.5 m. high, the young twigs lanate, the branches stiff. Leaves cuneate-obovate or nearly elliptic, small, 5–10 mm. long, nearly as wide as long, sharply 1–3-toothed on each margin, coriaceous, obtuse or subtruncate at the apex, glabrous and densely reticulate-veined above, white-lanate beneath, the petioles about 1 mm. long; heads solitary on short branchlets; involucre 1.5–2 cm. high, its bracts in about 4 series, loosely and sparingly lanate, the outer ovate, acute, the inner narrowly lanceolate, acuminate; achenes linear, 4 mm. long, densely pubescent; pappus yellowish-brown, about 3 times as long as the achene.

Coral rock hillsides and coastal cliffs, United States Naval Station, Guantanamo Bay, Oriente, Cuba (*Britton 2042, type; 2220*).

11. **Anastraphia parvifolia** sp. nov.

An upright shrub, 2 m. high, the young twigs lanate. Leaves oblong to oblong-obovate, small, 5–10 mm. long, 4–6 mm. wide, coriaceous, obtuse at the apex, obtuse or narrowed at the base, dark green, smooth and shining above, white-lanate beneath, the margin repand-denticulate, the slender petiole 1–3 mm. long; involucre about 2.4 cm. long, its bracts in 5 or 6 series, the outer ovate to ovate-lanceolate, loosely lanate, acute, the inner linear-lanceolate, acuminate, with lanate tips; corolla orange-yellow, 18 mm. long; achenes linear, densely pubescent, about 3 mm. long; pappus yellowish-brown, about 5 times as long as the achene.

Dense thickets in barren savannas southeast of Holguin, Oriente, Cuba (*Shafer 2938*).

12. **Anastraphia Wilsoni** sp. nov.

An intricately branched shrub 2 m. high, the young twigs somewhat lanate. Leaves oblong to oblong-obovate, subcoria-

ceous, 1–2.5 cm. long, 1 cm. wide or less, obtuse or acute at the apex, narrowed at the base, green, shining, and densely finely reticulate-veined above, brownish-tomentulose and prominently veined beneath, the margins strongly spinulose-dentate, the slender petioles 1.5–3 mm. long; heads solitary on short branchlets; involucre 1–1.5 cm. high, its bracts in about 8 series, the outer ovate, acute, densely lanate, the inner lanceolate to linear-lanceolate, attenuate, nearly glabrous; corolla 1.5 cm. long; achenes densely pubescent, 5 mm. long; pappus tawny, 3 times as long as the achene.

Rocky bank, Rio Toyaba, near Trinidad, province of Santa Clara, Cuba (*Britton & Wilson 5573*).

13. ANASTRAPHIA INTERTEXTA C. Wright; Griseb. Cat. Pl. Cub. 158. 1866

TYPE LOCALITY: Near San Marcos, district of Bahia Honda, Pinar del Rio, Cuba.

DISTRIBUTION: Mountain sides, Pinar del Rio, Cuba.

14. **Anastraphia Shaferi** sp. nov.

An intricately branched shrub 2–2.5 m. high, the young twigs lanate. Leaves oblong to oblong-oblanceolate, 10–18 mm. long, 8 mm. wide or less, coriaceous, sharply spinulose-dentate, obtuse at the apex, narrowed at the base, green, glabrous and smooth above, whitish-lanate and rather prominently veined beneath, the petioles about 1.5 mm. long; heads solitary or sometimes 2 together at the ends of branchlets; involucre about 1 cm. long, its villous-lanate bracts in about 5 series, the outer ovate, the inner lanceolate, acuminate; corolla "whitish," about 11 mm. long; achenes villous-pubescent, 3 mm. long; pappus tawny, 2–3 times as long as the achene.

Dry cliff, below the falls of Rio Naranja, Oriente, Cuba, 450–550 m. elevation (*Shafer 3865*).

15. **Anastraphia obtusifolia** sp. nov.

An intricately branched shrub, the young twigs lanate-tomentulose. Leaves oblong to oblanceolate, 2.5 cm. long or less, 4–10 mm. wide, coriaceous, entire-margined, dark green and finely densely reticulate-veined above, white-lanate and inconspicuously veined beneath, obtuse at the apex, narrowed at the base, the petioles 1–1.5 mm. long; head (only one old one seen

attached) sessile, lateral; involucre 9–10 mm. long, its bracts in 5 or 6 series, the outer ovate, acute; the inner linear-lanceolate, acuminate.

Camp La Gloria, south of Sierra Moa, Oriente, Cuba (*Shafer 8189*).

16. ANASTRAPHIA MICROCEPHALA Griseb. Cat. Pl. Cub. 158. 1866

TYPE LOCALITY: Eastern Cuba.

DISTRIBUTION: Known only from the type specimens collected by Wright.

17. **Anastraphia Rosei** sp. nov.

A shrub with tortuous branches, the young twigs floccose. Leaves broadly elliptic, elliptic-obovate or suborbicular, 10–15 mm. long, 8–13 mm. wide, obtuse or nearly truncate at the apex, obtuse or subtruncate at the base, dark green, loosely floccose or becoming glabrate, and finely reticulate-veined above, densely white-tomentulose and with few rather prominent veins beneath, spiny-toothed, with 2 or 3 teeth on each side, the slender tomentulose petioles 3–5 mm. long; heads solitary and sessile on short spurs, about 10-flowered; involucre narrowly obconic, 10–11 mm. long, its bracts in about 5 series, all appressed-villous, acute, the outer ovate, the inner linear-lanceolate; achenes densely silky, 4 mm. long; pappus yellow-brown, 8 mm. long.

Hillside, Azua, Santo Domingo, March 18, 1913 (*Rose, Fitch & Russell 4023*). Related to *A. Buchii* Urban, of Haiti, which has leaves cuneate at base, smaller heads and less hairy involucre-bracts.

18. ANASTRAPHIA BUCHII Urban, Symb. Ant. 5: 527. 1908

TYPE LOCALITY: Dry woods, Poste Coudau, Haiti, at 100 m. elevation.

DISTRIBUTION: Known only from the type locality.

19. ANASTRAPHIA NORTHROPIANA Greenm.; Combs, Trans. Acad. Sci. St. Louis 7: 435. *pl. 36.* 1897

Anastraphia Northropiana Combsii Urban, Symb. Ant. 3: 417. 1903.

TYPE LOCALITY: Fresh Creek, Andros, Bahamas.

BAHAMA ISLANDS: Andros, New Providence, Cat Island.

CUBA: On rocky coastal hills, Punta Piedra, Nipe Bay, Oriente (*Britton & Cowell 12459*); harbor of Santiago, Oriente (*Britton 1877*); near Nuevitas, Camaguey (*Shafer 839*); Calicita, Santa Clara (*Combs 521*); Rio San Juan, Santa Clara (*Britton, Earle & Wilson 5839, 5864*); apparently the same species, collected in foliage only, on Cayo Ratones, Bay of Mariel, Pinar del Rio (*Britton & Gager 7678*). I cannot specifically distinguish the Cuban plant from the Bahamian; on the southern coast of Santa Clara Province it forms a tree up to 10 m. high with a trunk 2 dm. in diameter; its bark is very rough.

20. **Anastraphia recurva** sp. nov.

A much-branched shrub up to about 3 m. high, the young twigs tomentulose. Leaves oblong to elliptic or oblanceolate, coriaceous, 4 cm. long or less, 8–15 mm. wide, green and smooth or somewhat reticulate-veined above, lanate beneath, obtuse or acute at the apex, cuneate-narrowed, acute or obtuse at the base, spinulose-dentate or entire, the petioles 1.5–3 mm. long; heads solitary at the ends of branchlets; involucre broadly campanulate, 1.5–1.8 cm. high, its bracts densely villous, imbricated in 6 or 7 series, recurved-spreading, linear-lanceolate, acuminate; corolla yellow or yellowish, about 1 cm. long; achenes densely whitish-pubescent, about 4 mm. long; pappus tawny, 2–3 times as long as the achene.

Serpentine hills near mouth of Rio Yamaniguey, Oriente, Cuba (*Shafer 4257; type*); between Rio Yamaniguey and Camp Toa, 400 m. alt. (*Shafer 4011*); vicinity of Camp San Benito, 900 m. alt. (*Shafer 4177*); Camp La Gloria, south of Sierra Moa (*Shafer 8187, 8266*); between Camp La Barga and Camp San Benito (*Shafer 4120*).

A species which has wide variation in leaf-forms; the involucre in all specimens seen appears to be the same.

21. **Anastraphia** (?) **lomensis** sp. nov.

A shrub about 2.5 m. high, the twigs tomentulose. Leaves oblong, coriaceous, about 4 cm. long and 1.8 cm. wide, entire-margined, or rarely with a spinulose tooth near the apex, spinulose-tipped and acute, or rounded at the apex, narrowed or obtuse at the base, faintly reticulate-veined, green and glabrous above, lanate and rather prominently veined beneath, the petioles 2–3.5

mm. long; heads solitary or sometimes 2 together at the ends of twigs; young involucre 1 cm. long, its floccose bracts in about 5 series, acute, the outer ovate, the inner lanceolate.

Rocky mountain side, Loma Mensura, about 800 m. alt., Oriente, Cuba (*Shafer 3811*).

The leaves are similar to those of *A. Picardae* Urban, of Haiti.

38. UNDESCRIBED WEST INDIAN SPECIES

Cyperus calcicola sp. nov.

Perennial by short rootstocks; culms slender, tufted, smooth, 1–2.5 dm. high. Leaves shorter than the culm, 0.5–1 mm. wide; bracts of the involucre 2 or 3, the longer sometimes 4 cm. long, similar to the leaves; head globose, solitary, 5–7 mm. in diameter; spikelets about 3-flowered, 3.5–4.5 mm. long; scales dark brown, the lowest empty ones persistent on the axis after the fall of the rest of the spikelet, lanceolate, the others ovate to ovate-lanceolate, acute, faintly striate-nerved.

Limestone rocks, Cayo Muertos, Porto Rico (*Britton, Cowell & Brown 4976*).

Related to *C. fuligineus* Chapm., in which the scales of the spikelet are more numerous, strongly striate-nerved and mucronate.

Psilocarya portoricensis sp. nov.

Annual, with fibrous roots; culm rather slender, about 4 dm. high. Leaves shorter than the culm, 2–3 mm. wide; umbels several, slender-stalked; spikelets 3–5 in the umbels, ovoid, acutish, 4–6 mm. long, 2 mm. thick; scales ovate, dark brown, sharply acute; style rather deeply 2-cleft; achene oblong, 1 mm. long, transversely wrinkled; tubercle triangular, acute, one third to one half as long as the achene, and distinctly decurrent upon it.

Shore of Laguna Tortuguero, Porto Rico (*Britton, Cowell & Brown 3850*).

Nearest to *P. nitens* (Vahl) A. Wood, of eastern continental North America, the achene of which is smaller, suborbicular and the tubercle scarcely decurrent.

Rynchospora borinquensis sp. nov.

Perennial by short rootstocks; culms slender, trigonous, about 6 dm. high. Leaves flat, about 2 mm. wide, shorter than the culm;

corymbs 2 or 3, distant, filiform-stalked, compound, narrow, 2–7 cm. long; spikelets clustered, fusiform, 5 mm. long, narrowed at both ends, bearing only 1 achene; scales lanceolate or oblong-lanceolate, dark brown, acute; bristles about 6, upwardly barbed, longer than the achene and tubercle; style-branches about one-third as long as the undivided part; achene oblong-obovate, faintly transversely wrinkled, 1.5 mm. long, a little longer than the smooth, conic, acute tubercle.

Open wet places in the forest, Rio Icaco and adjacent hills, Sierra de Naguabo, Porto Rico, 465–720 m. alt. (*Shafer 3515, type*); Sierra Nipe, Oriente, Cuba (*Shafer 3453, 3638*).

Apparently nearest *R. glauca* Vahl, which has shorter, ovoid spikelets, and a shorter tubercle.

Cassia clarendonensis sp. nov.

A finely pubescent shrub about 1.3 m. high. Leaves linear in outline, 10–15 cm. long, bearing an obtusely conic gland 1 mm. high between the lowest pair of leaflets, the slender, pubescent rachis angular; leaflets 10–15 pairs, thin, pubescent on both sides, with very short pubescent petiolules, apiculate, inequilateral, the upper 2 or 3 pairs oblong, 1.5–2 cm. long, 6–7 mm. wide, the others elliptic to obovate-elliptic, shorter and slightly broader; flowers in several short pubescent panicles in the upper axils; pedicels 2–4 mm. long; sepals obliquely elliptic, obtuse, pubescent, 5–6 mm. long; petals yellow, obovate, veiny, about 9 mm. long, rather abruptly short-clawed; sepals 7; larger anthers curved, 7–8 mm. long, the smaller nearly straight, about 5 mm. long; style curved, about 11 mm. long; pods short-stalked in the calyx, linear, many-seeded, densely puberulent, 7–10 cm. long, 6 mm. wide, flat, impressed between the seeds, the margins scarcely thickened; seeds oblong, transverse, pubescent, about 4 mm. long.

Inverness, Clarendon, Jamaica (*Harris 11693*).

Purdiaea velutina Britton & Wilson, sp. nov.

A shrub 3 m. tall, or a small tree; twigs villous. Leaves obovate, 4–10 cm. long, 2–3.3 cm. broad, rounded and emarginate or mucronate at the apex, gradually tapering to a rather broad sessile base, 5–7-ribbed, reticulate-veined, glabrous; bracts oblong-obovate or obovate, 15–24 mm. long, 6–9 mm. broad, velutinous on the back, glabrous within above the middle, below clothed with rather short, appressed silky hairs; peduncles and pedicels villous; one ciliate, the three outer ones unequal, ovate, 9–12 cm. long,

4–6 mm. broad, rounded or acutish and apiculate at the apex, papery, several nerved, the two inner sepals lanceolate, 5–6 mm. long, acuminate; petals lanceolate to narrowly ovate-lanceolate, 5.5–6 mm. long, 2–2.5 mm. broad, acute, glabrous; filaments subulate, glabrous; anthers oblong; ovary subglobose, villous.

Type collected along trail, Rio Yamaniguey to Camp Toa, Oriente, Cuba (*Shafer 4474*); also collected in the vicinity of Camp San Benito, Oriente, Cuba (*Shafer 4092*).

Purdiaea Shaferi Britton & Wilson, sp. nov.

A shrub 2 or 3 m. tall; twigs glabrous or nearly so. Leaves broadly elliptic-obovate, 4.5–9.5 cm. long, 2.5–4.5 cm. broad, rounded and emarginate or mucronate at the apex, sessile, 7–9-ribbed, rather faintly and coarsely reticulate-veined, glabrous; bracts obovate, 12–14 mm. long, 7–8 mm. broad, papillose; peduncles and pedicels villous; sepals 5, ciliate, the three outer sepals very unequal, broadly ovate to ovate-oval, 8–12 mm. long, 4–8 mm. broad, rounded or acute and apiculate at the apex, papery, clothed mostly toward the base with appressed, silky hairs, several-nerved, the two inner sepals lanceolate, 5–6 mm. long, 2 mm. broad, acuminate; petals elliptic, 5 mm. long, 2.5–3.2 mm. broad, mucronate, glabrous; filaments subulate, glabrous; anthers oblong; ovary globose-ovoid, hirsute; style subulate.

Type collected in pinelands, vicinity of Baracoa, Oriente, Cuba (*Shafer 4285*).

Purdiaea microphylla Britton & Wilson, sp. nov.

A shrub 1 or 2 m. tall; young twigs and branches of the inflorescence more or less hirsute. Leaves oblanceolate to obovate, 10–15 mm. long, 5–7 mm. broad, acute at the apex, cuneate at the base, sessile, rigid, faintly 3-ribbed, glabrous; sepals unequal, rigid, the three outer ones ovate to oval, 4 mm. long, 3 mm. broad, acute, the two inner sepals ovate, 3 mm. long, 1.2–1.5 mm. broad, apiculate, ciliate; fruit 5-lobed, the angles keeled, 5-celled, glabrous; style subulate, persistent.

Type collected at Camp La Gloria, south of Sierra Moa, Oriente, Cuba (*Shafer 8265*).

Piriqueta cubensis Britton & Wilson, sp. nov.

A shrub 1–3 m. tall, the young twigs grooved, velvety-ferruginous with stellate hairs. Leaves oblanceolate or obovate, 4–8 cm.

long, 1–2.2 cm. broad, obtuse or acutish at the apex, cuneate at the base, petioled, above clothed with scattered stellate hairs, beneath velvety ferruginous with stellate hairs and reticulate-veined, the midvein and lateral nerves obscure or impressed above, prominent beneath; calyx-lobes oblong-lanceolate to ovate-lanceolate, 1.2–1.6 cm. long, 6–8 mm. broad, velvety-ferruginous; petals elliptic to somewhat oblanceolate, 1.6–1.8 cm. long, 5–6 mm. broad, glandular-ciliate; filaments filiform, glabrous; anthers oblong-lanceolate; ovary narrowly ovoid, tomentose; styles filiform, 2.5–2.7 cm. long, glabrous; capsule velvety-ferruginous, the valves ovate; seeds pyriform.

Type collected along trail, Rio Yamaniguey to Camp Toa (400 m. alt.), Oriente, Cuba (*Shafer 4190*); also collected on the Sierra Nipe, Oriente (*Shafer 3109*).

Rheedia Hessii sp. nov.

Young branches angled, slender, the older ones terete. Leaves opposite, coriaceous, clustered on short lateral twigs, narrowly lanceolate, 1.5–2.5 cm. long, 6 mm. wide or less, narrowed at the base into stout petioles 2–3 mm. long, spinulose-acuminate at the apex, the midvein prominent beneath, very indistinct above, the lateral venation wholly obscure, the margins thickened; staminate flowers solitary in upper axils on pedicels about 4 mm. long; sepals suborbicular, about 3 mm. broad; petals obovate-elliptic, rounded at the apex, 5 mm. long; stamens numerous, the stout filaments 2–2.5 mm. long; anthers less than 0.5 mm. broad.

Indiera Fria, near Maricao, Porto Rico (*F. L. Stevens & W. E. Hess 3333*). In habit and in leaf-form this somewhat resembles *R. fruticosa* C. Wright, of Cuba.

Mayepea cubensis P. Wilson, sp. nov.

A shrub 6 m. tall, the young twigs glabrous or nearly so. Leaves oblong-oblanceolate, 6–9 cm. long, 1.5–2 cm. broad, rounded and often emarginate at the apex, cuneate at the base, petioled, glabrous, impressed punctate, rigid; midrib more or less impressed above, prominent beneath, the primary veins few and rather inconspicuous; panicles terminal, shorter than the leaves, the branches glabrous; bracts oblong-lanceolate or narrowly lanceolate, hirsutulous; pedicels about 2 mm. long; calyx-lobes triangular, obtuse or acutish, sparingly hirsutulous on the outside, hirsutulous within mostly at or near the apex; petals oblong or somewhat oblong-lanceolate, 5.5–6.5 mm. long, 1.2–2 mm. broad,

glabrous, obtuse, several-nerved; stamens shorter than the petals; filaments 1 mm. long; anthers elliptic-ovate to broadly elliptic; ovary ovoid, glabrous; stigma subsessile, globose-ovoid or subglobose, sometimes slightly emarginate.

Type collected at mouth of the Rio Yamaniguey, Oriente, Cuba (*Shafer 4253*).

Agalinis albida Britton & Pennell, sp. nov.

Annual; plant green, tending to blacken in drying. Stem 4–6 dm. tall, slender, with virgately ascending branches, obscurely striate-4-angled, glabrous; leaves opposite, or somewhat subopposite above, ascending or recurved-spreading, linear-subulate below to linear and longer above, entire, acute, those of the stem 1–2.5 cm. long, 0.5–1 mm. wide; bracts gradually much reduced; leaves thickened, minutely scabrous to scabro-roughened above. axillary fascicles none; racemes elongated, 2–16-flowered; pedicels ascending, slender, clavate, glabrous, in flower 0.5–1 mm. long, in fruit 2–3 mm. long, much shorter than the bracts; calyx-tube 2–2.5 mm. long, depressed-hemispheric, obscurely veined, 1/3–2/5 the length of the capsule, somewhat truncate, its lobes 0.7–1 mm. long, broadly triangular to ovate-triangular, acute to acuminate; apex of tube and lobes within sparingly puberulent; corolla 10–15 mm. long, spreading, 7–10 mm. wide, membranous, its tube 8–12 mm. long, straight to slightly upcurved, its lobes 2–3 mm. long, rounded to truncate, all somewhat spreading, without minutely pubescent, within slightly pubescent about the bases of the filaments, pubescent below sinus and over most of basal portions of posterior lobes; lobes all ciliate, white, at times shaded with violet; posterior filaments 2.5–3.5 mm. long, anterior 5–6.5 mm. long, all somewhat lanose; anther-sacs 1–1.5 mm. long, oblong-lanceolate, acute to mucronate at base, lanose-pubescent with white hairs on the valvular surface, glabrous on the sides; style 4–5 mm. long, filiform, glabrous; stigma 2.5 mm. long; capsule 4 mm. long, depressed-globose, dark-brown; seeds 0.6–0.8 mm. long, lunate-triangular to narrowly quadrangular, slightly less than one-half as broad as long, irregular; testa pale, with reticulations delicate, brown, enclosing elongated angular spaces; intrareticular lines very fine, forming a network.

Wet, grassy pineland, western Cuba, Isle of Pines, and in Jamaica.

Type, *Colpothrinax* savanna, vicinity of Herradura, province of Pinar del Rio, Cuba, collected in flower and fruit August 26–30, 1910 (*Britton, Earle & Gager 6475*).

CUBA. Pinar del Rio: Guane (*Shafer 10662*); Herradura (*Hermann 291, 565*); Laguna Jovero (*Shafer 10937*); Laguna los Indios (*Shafer 10801*); Pinar del Rio (*Wright 2991 p.p.*); San Cristobal (*Wright 2991 p.p.*), Santa Clara: Cieneguita (*Combs 443*), Isle of Pines: Managua (*Palmer & Riley 1102*).

JAMAICA. Shooter's Savanna (*Harris 11160*); Upper Clarendon (*Harris 11100*).

Differs from other species of *Agalinis* bearing short-pedicelled flowers, spreading corolla-lobes and dark brown seeds (*A. purpurea* and near allies) by its leaves strongly ascending, but 1–2.5 cm. long, its corolla much paler, nearly or quite white, and relatively small, and by its seeds which are less than one-half as broad as long.

Jacaranda Cowellii Britton & Wilson, sp. nov.

A shrub 1.5–2 m. tall, the young twigs, pedicels, calyx and corolla more or less glandular-pubescent; leaves once-pinnate, 2.5–6 cm. long, occasionally longer; petioles and rachis narrowly grooved; leaflets 8–15 pairs or more, opposite or subopposite, elliptic to oval or orbicular, 2–5 mm. long, 1.5–3 mm. broad, sessile, rigid, green and lustrous above, paler beneath, the margin strongly involute, the midvein impressed above, prominent beneath; bracts of the inflorescence oblong; calyx-lobes triangular-ovate or ovate, acutish, 2 mm. long; corolla-tube 2–2.5 cm. long, the lobes orbicular; filaments of the fertile stamens subulate, glabrous, the filament of the sterile stamen flattened, bearded below the middle, glabrous above, densely bearded at the apex; anthers oblong-elliptic; ovary ovoid, glabrous; style subulate; fruit elliptic or oblong-elliptic, the apex rounded, or abruptly short-acuminate with the tip acutish or obtuse.

Type collected in palm barrens in the vicinity of the city of Santa Clara, Cuba (*Britton & Cowell 13316*); also collected at the same locality (*Britton & Wilson 6071; Britton & Cowell 10174*); dry hill, Holguin, Oriente (*Shafer 12434*); barren savanna southeast of Holguin, Oriente (*Shafer 2940*).

Mosses from the west coast of South America

R. S. Williams

(WITH PLATES 21–25)

A list of mosses collected by Dr. and Mrs. J. N. Rose in Peru, Bolivia and Chile, July to October, 1914, while on a trip undertaken chiefly for the purpose of obtaining Cactaceae.

This collection of 41 mosses, coming as it does largely from the dry cactus region of the west coast of South America, contains for its size an unusually large number of interesting species.

CAMPYLOPUS INCRASSATUS (Kze.) C. M.

PERU: near Mollendo, *18996*.

Campylopus peruvianus sp. nov.

Sterile: plants in compact cushions with more or less branching stems, radiculose below, and 10–15 mm. high; leaves ovate-lanceolate, entire except at the apex, closely imbricate, erect-appressed when dry, somewhat spreading when moist, the upper rather larger, 3–4 mm. long, mostly with a short, rough, hyaline point rarely more than 0.5 mm. long; costa about one half the width of the leaf in the lower part, in cross-section showing stereid bands above and below the guide cells and bearing on the back about 24, not serrate, lamellae up to 4 cells in height; alar cells enlarged, mostly pale, extending to the costa; marginal cells of lower leaf narrow and elongate, forming a narrow, hyaline border sometimes extending half way up the leaf; the median cells mostly short-rhomboidal, those just above the alar, short rectangular, all with slightly thickened not pitted walls.

PERU: near Mollendo, August, *18997*.

Astomum chilense sp. nov.

Dioicous, the inconspicuous male flowers containing 5 or 6 antheridia with few paraphyses, enclosed by 2 or 3 very small inner perigonial leaves; the outer leaves being scarcely differentiated: plants in rather compact mats with simple stems about 1 mm. high, bearing radicles at base; stem-leaves up to 1.5 mm., rarely 2 mm. long, ovate-lanceolate, more or less folded and crispate when dry, rather widely spreading when moist, with flat, entire margins; costa excurrent into a short apiculus, in cross-

section showing 2 large guide cells, a rather small stereid band between them and the row of large cells next the upper surface, and below the guide cells a much larger stereid band with outer cells somewhat enlarged; cells in lower part of leaf pale, smooth, mostly short-rectangular, about 8 μ wide by 12 μ long, in upper part densely papillose, rather distinct, nearly square, about 6 × 6 μ; perichaetial leaves scarcely differentiated; seta often somewhat bent and twisted when dry, erect when moist, about 2.5 mm. long; capsule oblong, slightly wrinkled when dry, about 1 mm. long, including the short, oblique beak; spores rough, about 16 μ in diameter; calyptra cucullate, smooth, descending about half way down the capsule.

CHILE: vicinity of La Serena, October, *19290*.

GYROWEISIA BOLIVIANA R. S. Williams, Bull. N. Y. Bot. Gard. 3: 104. 1903.

PERU: Cuzco, September, *19057*.

LEPTODONTIUM GRACILE C. M.

PERU: vicinity of Lima, July, *18594*.

BARBULA FUSCINERVIA Mitt.

PERU: Juliaca, September, *19092*.

BARBULA FUSCO-VIRIDIS Broth.

CHILE: Palos Quemnados, October, *19184;* La Ligua, October, *19532*.

BARBULA REPLICATA Tayl.

PERU: near Oroya, July, *18717*; Arequipa, July, *19531;* Posco, July, *18813;* Cuzco, August, *19055*.

Pterogoneurum Roseae sp. nov.

Autoicous, the male flower terminal, the outer perigonial leaves not differentiated, the inner with a very small, pale-golden, roundish, scarcely costate blade bearing a rough, hyaline hair-point 3 or 4 times as long, enclosing 5 or 6 antheridia about 50 μ long and numerous, somewhat club-shaped paraphyses twice as long as the antheridia: plants appearing somewhat gregarious, only 2–3 mm. high, with very short stems and crowded, bud-like branches; stem leaves when dry, erect, appressed-imbricate, when moist, widely spreading, broadly ovate, serrulate nearly to the base, the blade about 1 mm. long with a rough, hyaline hair-point often exceeding the blade in length, the margins of the upper half of the blade broadly inflexed over the costa; costa expanded in the upper half, in cross-section showing a broad stereid band below

the single row of large cells bearing about 20 rows of filaments 3–5 cells high with the terminal cell often contracted into a mamillate apex; basal cells of leaf pale, short-rectangular to square, up to 20 μ wide and about 25 μ long, with walls slightly thickened at the angles, the cells about one half up the leaf becoming more or less transversely elongate, especially toward the margin, with unequally thickened, not pitted, walls; outer perichaetial leaves not differentiated, the 1 or 2 inner leaves very small, pale, narrowly lanceolate, nearly ecostate; seta reddish, 8–9 mm. high; capsule ovate-oblong, nearly symmetric and erect, 2 mm. long with the lid; lid conic, about as high as its basal diameter; peristome papillose, very irregular, from a low basal membrane, the teeth varying from long-lanceolate to little more than lobes scarcely projecting above the annulus; annulus persistent, of a single row of large cells; calyptra cucullate, smooth, extending about half way down the capsule; spores slightly rough, up to 24 μ in diameter.

PERU: vicinity of Lima, July, *18595* (type); Posco, August, *18813a*.

Crossidium Rosei sp. nov.

Autoicous, the male flowers at the apex of the branches, the inner perigonial leaves smaller than the outer, otherwise scarcely differentiated, the 6 to 8 antheridia about 0.25 mm. long, with rather numerous, often longer, filiform paraphyses: plants in rather compact mats, the short stems, with radicles at base, bearing several short branches crowded together bud-like, and 2–3 mm. high; leaves when dry appressed-incurved, often somewhat crispate, when moist, erect-spreading, ovate-oblong to oblong-spatulate, 2–2.5 mm. long, in the upper third finely papillose on both sides, the margins entire and flat or more or less recurved; costa slightly excurrent, enlarged in the upper half, in cross-section showing a large stereid band on the under side and on the upper side some 6–8 large cells, mostly in one row, bearing numerous, short, somewhat club-shaped filaments 2 or 3 cells high with the terminal cell papillose; leaf cells distinct throughout, the basal pale green, nearly square to short-rectangular, up to 20 μ wide by about 35 μ long, the median cells scarcely elongate, about 16 $\times$ 16 μ, with walls scarcely thickened; perichaetial leaves hardly differentiated, the inner usually smaller; seta rather flexuous, about 8 mm. long; capsule erect, nearly symmetric, oblong, about 1.5 mm. long with the lid; lid conic, acute, a little higher than its basal diameter, the cells, except at the base, elongate in oblique rows; peristome a papillose basal membrane extending 3 or 4 rows of cells above the persistent annulus, its margin more or less incised and bearing

here and there short lobes; calyptra cucullate, smooth, descending well below the lid; spores rough, up to 25 μ in diameter.

PERU: vicinity of Lima, July, *18774*.

PSEUDOCROSSIDIUM gen. nov.

Dioicous. Small plants with simple or slightly branched stems having a distinct central strand and leaves, when dry, erect-appressed or sometimes twisted about the stem. Stem-leaves with margins in the upper part once to twice revolute, the upper side of the revolute part with cells often much inflated or with greatly enlarged papillae. Costa broader in the upper part than below, nearly percurrent or excurrent; in cross-section about two thirds up showing 5 to 8 guide cells, mostly in one row, beneath them a large stereid band and on the upper side numerous lax, thin-walled cells in 1 to 3 layers forming a continuous, densely papillose surface or sometimes more or less broken up into filaments 2 or 3 cells high with the terminal cells papillose (occasionally, also, a thin band of stereid cells just above the guide-cells in *P. apiculatum*). Cells of the upper part of leaf not or slightly elongate, mostly obscure with crowded papillae on one or both sides, in the lower part, smooth, pale, rectangular or short, more or less transversely elongate. Perichaetial leaves greatly differentiated, the 2 or 3 inner much larger than those of the stem, convolute, pale throughout, with narrow costa mostly vanishing below the obtuse or truncate, nearly or quite entire apex. Capsule nearly cylindric and erect with a slightly oblique, subulate lid. Peristome of 32 slender, papillose teeth twisted to the left, from a low basal membrane. Annulus of 2 or 3 rows of persistent cells. Calyptra cucullate.

Type species, *P. chilense*.

Pseudocrossidium chilense sp. nov.

Evidently dioicous, the male flowers not found: plants in brownish green cushions with somewhat branching stems, 2–4 mm. high, with a very distinct central strand and walls of outer cells scarcely thickened; stem-leaves erect-appressed when dry, more or less broadly ovate, obtusely or acutely pointed, the upper about 1 mm. long, the lower shorter, rather deeply keeled above with the margins strongly revolute half way down or more; costa nearly percurrent, enlarged in the upper half, 120–140 μ wide, in cross-section above the middle showing 6 to 9 guide-cells mostly in one row, below them a large stereid band and on the upper side 2 or 3 layers of lax, thin-walled cells, those at the surface densely papillose and sometimes more or less separated; cells of upper

part of leaf scarcely elongate, about 6 μ in diameter, more or less papillose on both sides, in lower part, paler, smooth, mostly nearly square to transversely elongate, often 12 × 12 μ; perichaetial leaves projecting well above those of the stem, the 2 or 3 inner convolute, about 2 mm. long, mostly broadly rounded or truncate at the entire or nearly entire apex, the leaf-cells mostly slightly elongate throughout with lax, thin walls, smooth or finely papillose on the back in the upper part; seta erect, about 1 cm. long; capsule cylindric, about 2.25 mm. long without lid, the stoutly beaked lid nearly erect, 1 mm. long, with the elongate cells in oblique rows; peristome of 32 slender papillose teeth, twisted about one half around to the left, from a rather low basal membrane; annulus of 2 or 3 rows of small cells; calyptra cucullate, smooth; spores smooth, about 10 μ in diameter.

CHILE: near Valparaiso, September *19132b*.

Pseudocrossidium apiculatum sp. nov.

Dioicous, the outer perigonal leaves like those of the upper stem, the inner much shorter, broadly ovate, with narrow costa, enclosing numerous antheridia, 0.4 mm. long, and abundant, slightly club-shaped paraphyses: plants in compact, greenish brown mats with mostly simple stems 1 cm. high, with large, very distinct central stand and outer walls of 1 or 2 rows of rather small cells with scarcely thickened cell-walls; stem-leaves ovate-lanceolate, acute, the upper about 1.5 mm. long, appressed and mostly twisted about the stem when dry, the margins in the upper half often twice revolute; costa excurrent, apiculate, in the widest part 140–160 μ across, in cross-section showing 6 to 8 guide cells, below them a large stereid band and on the upper side 3 or 4 layers of lax, thin-walled cells forming a compact densely papillose surface or broken up into distinct filaments 2 or 3 cells high with the terminal cell papillose (sometimes also a thin band of stereid cells occurs just above the guide-cells); cells of upper leaf mostly not elongate or transversely elongate, often 12 × 12 μ, papillose on both sides, those of the revolute part often much inflated or with greatly enlarged papillae on the upper face; lower cells of leaf paler, mostly rectangular, 12–16 μ wide and 20–40 μ long; perichaetial leaves pale, convolute, the inner 2.5 mm. long or more, projecting well above the stem-leaves, somewhat obovate to oblong, the apex obtusely rounded and more or less erose, the costa narrow and vanishing a little below the apex; fruit unknown.

PERU: above Arequipa, August, *18977*.

[**Pseudocrossidium excavatum** (Mitt.) comb. nov.

To this genus I would also refer *Tortula excavata* Mitt. Jour.

Linn. Soc. **12**: 154. 1869. It has a cross section of leaf and perichaetial leaves very similar to the preceding but is a much smaller species with stem leaves only about 0.5 mm. long and lacking the sharp apiculate point. From *P. chilense* it may be at once distinguished by the basal cells which are rectangular, not mostly transversely elongate or square. The costa is also narrower, about 60 μ in the widest part. It seems to be known only from the Andes near Quito.]

Desmatodon subtophaceus (R. S. Williams) comb. nov.

Didymodon subtophaceus R. S. Williams, Bull. N. Y. Bot. Gard. **3**: 119. 1903.

PERU: above Arequipa, August, *19533;* Juliaca, September, *19099.*

CHILE: Las Vacas, near Chiapa, October, *19230.*

The stereid band is nearly or quite lacking in the upper part of the costa but present in the lower part.

TORTULA CONFUSA Card.

PERU: Cuzco, September, *19519.*

TORTULA KUNZEANA (C. M.) Mitt.

CHILE: La Ligua, *19383;* Paloma, October, *19354.*

Tortula limensis sp. nov.

Apparently mostly autoicous but occasionally synoicous, the inner perigonial leaves much smaller and paler than the outer and enclosing abundant antheridia, 0.3–0.4 mm. long, with numerous slightly longer, club-shaped paraphyses: plants in compact mats with more or less branching; stems about 1 cm. high having a very small central strand or none; stem-leaves mostly oblong, the larger about 3 mm. long by 1.5 mm. wide, appressed-contorted when dry, somewhat spreading, recurved when moist, with flat or slightly recurved crenulate and papillose margins; costa terete, slightly rough on the back, about 40 μ wide in the lower part, slightly tapering upward, excurrent into a reddish not quite smooth hair-point sometimes over one half the length of the blade, in cross-section showing 2 large guide-cells, below them a stereid band and on the upper side a few thin-walled cells in two layers, the upper surface finely papillose; cells of upper leaf not elongate, densely papillose on both sides, 16–20 μ in diameter, those of basal part pale, smooth, up to 25 μ wide and 60–80 μ long; inner perichaetial leaves very similar to those of the stem but a little larger; seta about 12 mm. long; capsule oblong, slightly curved

and nodding, 2.5 mm. long without the lid, the lid conic, in height often but little exceeding its basal diameter; peristome of 32 pale, nearly erect, very papillose teeth more or less contracted at the joints, from a basal membrane about one-tenth the height of the teeth; annulus of 1 or 2 rows of small cells adherent to the rim of the capsule; calyptra cucullate, descending well below the base of the lid; spores slightly rough, up to 25 μ in diameter.

PERU: Lima, July, *18603c* (type), *18603a;* north of Lima, July, *19523*.

A species much like some forms of *T. montana* in general appearance.

Tortula minuscula sp. nov.

Dioicous, the terminal bud-like male flower at length appearing lateral by the growth of a subapical branch; the antheridia about 0.3 mm. long, with abundant slightly club-shaped paraphyses: plants in compact, dusky green mats with often branching stems 5–8 mm. high, having a distinct central strand; stem-leaves about 2 mm. long, appressed or somewhat erect-spreading when dry, rather broadly ovate-lanceolate, entire, the margins somewhat recurved along the middle and thickened with 1 row of additional cells in the narrow-grooved point; costa percurrent, often slightly broadened and flattened near the middle of the leaf with a cross-section showing 10 to 12 guide cells, a single row of cells nearly as large on the ventral side and on the dorsal side a row of slightly smaller cells with a few stereid cells between them and the guide-cells; the cross-section near apex shows no stereid cells and only 2 guide-cells; cells of upper part of leaf very papillose on both sides, the median often slightly transversely elongate, about 5×8 μ, the basal short-rectangular to nearly square; perichaetial leaves very similar to those of upper stem but with slightly larger and paler base; seta 6–7 mm. long; capsule erect, ovate-oblong, about 1 mm. long without the lid; the lid slightly oblique, conic-subulate, scarcely 0.5 mm. long; peristome from a papillose basal membrane projecting well above the annulus, of 32 erect or nearly erect, very papillose teeth of irregular length; annulus of 2 or 3 rows of persistent cells; calyptra cucullate, smooth, descending well below the lid; spores smooth, about 10 μ in diameter.

PERU: Cuzco, September, *19520*.

TORTULA MURALIS (L.) Hedw.

CHILE: Viña del Mar, near Valparaiso, September, *19105*; Las Vacas, near Chiapa, *19230a*; vicinity of La Serena, *19289*; vicinity of Illapel, *19462*, *19462d*; La Paloma, October, *19522*.

ENCALYPTA EMERSA C. M.?

BOLIVIA: Comanche, August, *18884*.

This plant is perhaps distinct from *E. emersa*, of which I have seen no specimens. The Bolivian plant is autoicous with stems rather stout, about 2 cm. high; stem-leaves oblong, about 4 mm. long by 2 mm. broad, the apex rounded, the margins somewhat crenate and papillose; costa vanishing a little below the apex, rough on the back with pale spines, simple toward the apex, branching at the middle and lower part of the costa; capsule cylindric, nearly smooth, emergent, without peristome; calyptra entire at base, somewhat scabrous at apex.

ALIGRIMMIA PERUVIANA R. S. Williams, Bull. N. Y. Bot. Gard. 3: 124. 1903.

PERU: vicinity of Arequipa, August, *18823*, the locality from which the type specimens were described.

GRIMMIA MICRO-OVATA C. M.

BOLIVIA: Comanche, August, *18882a*; vicinity of Comanche, August, *18882*; vicinity of La Paz, August, *18870*.

GRIMMIA SAXATILIS Mitt.

PERU: Juliaca, September, *19091*.

ZYGODON CIRCINATUS Mitt.

PERU: near Mollendo, August, *19526*. Type specimens collected on the island of Chiloe, Chile, and apparently unknown elsewhere, excepting from this Peruvian collection.

Physcomitrium Roseae sp. nov.

Antheridia not found: plants in thin mats or somewhat gregarious, with stems about 2 mm. high, scarcely projecting above the earth over which they grow with the rosette-like cluster of leaves resting on the surface; stems with a few radicles at the base and 5 to 7 leaves clustered at the apex; leaves mostly ovate, acute, with flat, entire margins, about 2.5 mm. long by 1.5 mm. wide, with sometimes 1 or 2 much smaller inner leaves; costa percurrent, weak, in cross-section showing 5 or 6 cells of somewhat variable size without thickened walls; cells of upper part of leaf more or less hexagonal, 20–25 μ in diameter, toward the base square to rectangular, about 25 μ wide and 30–50 μ long; seta 2 mm. long; capsule subglobose, about 1.5 mm. high, without annulus and peristome, the cells about the rim elongate in 5 or 6

rows, forming a rather ill-defined border, those below to near the base very irregular, becoming at the base smaller, quite regular and with small stomata in several rows; lid nearly flat, with an ill-defined border of transversely elongate cells that become toward the center of lid much broader and larger; spores mostly roundish, smooth, 28–30 μ in diameter; calyptra (perhaps not normal) remaining attached to the seta half way down the capsule, terete-cylindric, smooth.

CHILE: near Valparaiso, September, *19176*.

FUNARIA CALVESCENS Schwaegr.

BOLIVIA: vicinity of La Paz, August, *18858*.

FUNARIA HYGROMETRICA (L.) Sibth.

PERU: vicinity of Chosica, June, *18549*; Arequipa and vicinity, August, *18822*, *19001;* Juliaca, September, *19098*.

CHILE: near Valapraiso, September, *19106*, *19107*, *19132a;* Santiago, September, *19181*.

FUNARIA MACROSPORA R. S. Williams, Bull. N. Y. Bot. Gard. 3: 133. 1903.

BOLIVIA: La Paz, August, *19463*; Araranca, August, *19527*.

PERU: Arequipa, August, *19528*. The spores in all these specimens are rough and the larger measure 25–30 μ. Possibly the species is not distinct from *F. hygrometrica*. The plants are all much larger than any specimens of *F. hygrometrica arctica* I have seen.

FUNARIA SUBERECTA Mitt.

CHILE: vicinity of Illapel, October, *19462a*.

MIELICHHOFERIA CAMPYLOTHECA C. M.

BOLIVIA: Comanche, August, *18884a*.

HAPLODONTIUM JAMESONI (Tayl.) Hpe.

PERU: Juliaca, September, *19097*.

HAPLODONTIUM SERIOLUM C. M.

PERU: Juliaca, September, *19518*.

LEPTOBRYUM PYRIFORME (L.) Wils.

BOLIVIA: Araranca, August, *19464*.

LEPTOBRYUM WILSONI (Mitt.) Broth.

PERU: Arequipa and vicinity, August, *19514*, *19517*.

ANOMOBRYUM FILIFORME (Dicks.) Husn.

PERU: above Toyatoya, August *18941;* Juliaca, September, *19101*.

BRYUM CONCAVUM Mitt.

BOLIVIA: La Paz, August *18895*, *18896*, *19463a*.

PERU: Arequipa, August, *19529;* Cuzco, September, *19056*, *19058*.

BARTRAMIA FRAGILIFOLIA C. M.

BOLIVIA: vicinity of Comanche, August, *19524*.

Philonotis fragilicaulis sp. nov.

Flowers and fruit not known; plants in compact cushions with slender, branching stems, mostly denuded of leaves in the lower part and without radicles, 3–4 dm. long and 0.25 mm. in diameter, having a large well-defined central strand and often rough surface in the older parts from the large, mamillose-inflated outer cells; leaves nearly erect and loosely imbricate-incurved when dry, scarcely spreading when moist, ovate-pointed, about 1.5 mm. long and 0.75 mm. wide, the margins flat, serrulate in the upper part, sometimes crenulate nearly to the base; costa stout, rough on the back in the upper half, excurrent into a serrulate, short or somewhat elongate and subulate point; cells of leaf on the under surface, more especially the median cells, mamillose-inflated at the base, those of the upper leaf mostly somewhat elongate, more or less quadratic, the median 8–12 μ wide and 20–30 μ long, the basal rather larger and more rectangular.

PERU: Araranca, 4260 m. alt., August, *19513*.

POGONATUM POLYCARPUM (Schimp.) Broth.

PERU: Juliaca, September, *19100*.

HEDWIGIDIUM IMBERBE (Sw.) Bry. Eur.

BOLIVIA: vicinity of Comanche, *18883*.

FABRONIA ANDINA Mitt.

BOLIVIA: vicinity of La Paz, August, *18857*, *18871;* Comanche, August, *19515*.

LESKEA GRACILLIMA Tayl.

PERU: Cuzco, September, *19059*, *19530*.

One specimen (No. 18603b) is not determined. It is possibly a small *Pohlia*, but lacks fruit and may belong elsewhere.

Explanation of plates 21-25

PLATE 21

Campylopus peruvianus. 1. Plant about natural size. 2. Stem-leaf, × 18. 3. Hyaline point of leaf, × 103. 4. Basal cells on one side of costa, × 124. 5. Median cells of leaf, × 124. 6. Half a cross-section near the middle of leaf, × 124.

Astomum chilense. 7. Plant about natural size. 8. Plant, × 10. 9. Apex of leaf, × 183. 10 and 11. Upper stem leaves, × 20. 12. Lower stem leaf, × 20. 13. Median cells of leaf, × 183. 14. Cross-section of leaf about half way down, × 124. 15. Basal cells on one side of costa, × 124.

PLATE 22

Pterogoneurum Roseae. 1. Plant about natural size. 2. Upper leaf, × 10. 3. Lower leaf, × 10. 4. Inner perichaetial leaf, × 10. 5. Calyptra, × 10. 6. Cells at the shoulder of leaf about half way up blade, × 124. 7. Apex of leaf-blade, × 46. 8. Capsule, × 10. 9. Half a cross-section near the middle of leaf, × 124. 10. Part of peristome, annulus and rim of capsule, × 124. 11. Basal cells from margin extending only part of the way to costa, × 124.

Crossidium Rosei. 12. Plant about natural size. 13. Calyptra, × 11. 14 and 15. Upper and middle stem leaves, × 18. 16. Basal cells on one side of costa, × 124. 17. Capsule, × 11. 18. Median leaf cells, × 124. 19. Cross-section about one third down leaf, × 103. 20. Part of peristome, annulus and rim of capsule, × 124.

PLATE 23

Pseudocrossidium chilense. 1. Plant about natural size. 2. Plant, × 9. 3 and 4. Perichaetial leaves, × 20. 5. Basal cells on one side of costa, × 124. 6 and 7. Upper and middle stem leaves, × 20. 8. Median cells of leaf, × 183. 9. Cross-section of leaf below the middle, × 124. 10. Cross-section above the middle, × 183.

Pseudocrossidium apiculatum. 11. Plant about natural size. 12. Plant, × 6. 13. Stem-leaves, × 13. 14. Perichaetial leaf, × 13. 15. Cells in upper leaf about midway between margin and costa, × 183. 16. Cells just above the rectangular basal cells, × 183. 17. Cross-section of leaf about one third down, × 124. 18. Basal cells of leaf from margin to costa, × 124. 19. Cross-section of a second leaf, × 183.

PLATE 24

Tortula minuscula. 1. Plant about natural size. 2. Calyptra, × 14. 3. Capsule, × 14. 4. Median exothecal cells, × 124. 5. Median cells of leaf, × 183. 6. Part of peristome, annulus and rim of capsule, × 183. 7. Perichaetial leaf, × 20. 8 and 9. Stem leaves, × 20. 10. Basal cells of leaf from margin to costa, × 183. 11. Cross-sections of costa in upper part and near the middle, × 183.

Tortula limensis. 12. Plant about natural size. 13 and 14. Stem-leaves, × 6. 15. Capsule, × 6. 16. Calyptra, × 6. 17. Cross-section of leaf, × 124. 18. Apex of leaf-blade and costa on under side, × 124. 19. Median cells of leaf, × 124. 20. Basal cells of leaf from margin to costa, × 124. 21. Part of peristome, annulus and rim of capsule, × 124.

PLATE 25

Physcomitrium Roseae. 1. Plant, × 5. 2. Leaf, × 14. 3. Apex of leaf, × 100. 4. Cells about rim of capsule, × 100. 5. Cells at base of capsule surrounding a stoma, × 100. 6. Median cells of leaf, × 100. 7. Cells of lid from margin to center, × 100. 8. Basal cells of leaf from margin to near the costa, × 100. 9. Part of cross-section of leaf near the middle, × 100.

Philonotis fragilicaulis. 10. Plant, about natural size. 11 and 12. Stem leaves, × 23. 13. Median cells of leaf showing mamillae at the lower and under surface, × 183. 14. Leaf at apex, × 183. 15. Basal cells of leaf from margin to costa, × 183. 16. Part of cross-section of leaf near the middle, × 183. 17. Part of cross-section of leaf a little below the middle, × 183.

Notes on Carex—VIII

KENNETH KENT MACKENZIE

CAREX STRICTA LAM. AND ITS ALLIES

Probably the only species of *Carex* growing in the vicinity of New York, which is abundant enough to make it the distinctive feature over large areas, is the tussock sedge, *Carex stricta* Lam. Every swamp is full of the great clumps of this plant, usually very largely to the exclusion of everything else. It is with difficulty that proper herbarium specimens can be made, as the root-stocks are very heavy and stout. In fact an axe or heavy spade is needed to dig out characteristic specimens. The result is that herbarium specimens are mostly very poor and usually consist of the culms broken off as close to the ground as possible.

The distinguishing features of this common plant are its habit of forming dense tussocks (or bogs in the vernacular sense), its not being loosely and strongly stoloniferous, its intensely deep green leaves, triangular or channelled at the base, usually light brown culm bases, and but slightly hispidulous sheaths. It is a very rough plant, the perigynia are strongly granular roughened, and the scales are usually light reddish brown tinged.

Another species which is widely distributed throughout the northeastern United States can be readily told in the field, but much less easily from the usual run of herbarium specimens. This plant grows in great beds and does not form tussocks. It produces many long horizontal stolons; the leaves, at first glaucous green, in age become light green or blue green, and contrast strongly with the leaves of *Carex stricta*, when growing near it; the culms at base are brown-purplish tinged, the sheaths are strongly hispidulous, and the scales vary from blackish to dark reddish brown in age, while the leaves are flat or nearly so to the base. The perigynia are slightly more beaked than in *Carex stricta*, and the lowest bract is noticeably larger. This species is *Carex strictior* Dewey. It has often been mistaken for *Carex*

aquatilis Wahl. by discriminating collectors, who have noticed that it was distinct from *Carex stricta*, and who could find no other name apparently available for it.

By far the most widely distributed species of this group in the eastern part of the United States, is a plant to which I am applying the name *Carex Emoryi* Dewey. This is a freely stoloniferous plant growing in beds like *Carex strictior*. It, however, is a much stouter plant, and the basal sheaths are not filamentose or hispidulous. The perigynia, which are abruptly and prominently short-beaked, are smooth under an ordinary lens except towards the apex and much resemble the perigynia of the *C. aquatilis* group. This species ranges from New York, western New Jersey and Maryland to Manitoba, Colorado and New Mexico, and has at various times been referred to *Carex stricta* or *Carex aquatilis*.

A slender species of this group with a northerly range is *Carex Haydeni* Dewey. This plant has broadly oval or suborbicular perigynia which are noticeably inflated and light brownish at maturity, in these characters being readily separable from other members of the group here discussed. The scales always exceed the perigynia and the spikes are small in size. While the culms are cespitose they are much less densely so than in *Carex stricta*. As far as I can make out the habit of growth is much like that of *Carex torta*, i. e., the plant has very short ascending stolons. The basal sheaths are often, but not always, entirely free from the filamentose fibers so evident in *Carex stricta*, and the culms are usually much darkened at the base.

The first three species referred to above all vary to a very considerable extent in the size of the pistillate spikes. Specimens with very short spikes, referable to *Carex strictior*, have been described as *Carex stricta* var. *curtissima* Peck. Such specimens have the perigynia very crowded, and on this account the perigynia not having a chance to properly develop often present a different appearance from specimens where they are less crowded. I regard these plants only as exhibiting individual peculiarities, and do not believe they should be given varietal recognition.

These same three species also often produce slender elongated pistillate spikes. Such specimens have of late years been going under the name *Carex stricta* var. *angustata* (Boott) Bailey, and

very narrow spiked forms have been called *Carex stricta* var. *xerocarpa* (S. H. Wright) Britton. However, the original *Carex angustata* Boott, on which the variety *angustata* is founded, is a plant from the Oregon-Washington region, and is entirely distinct from the eastern species. The narrow spiked specimens of the eastern plants do not seem worthy of recognition.

While it is not my intention in this paper to consider all the Pacific Coast species which are closely related to *Carex stricta*, I have included *Carex angustata* and certain plants confused with it. *Carex angustata* itself is distinguished from its eastern relatives by the finely many-nerved perigynia. It seems to be exactly the same plant afterwards described by Professor Bailey as *Carex acutina* and is of rare occurrence in collections. It is a slender plant with rather loosely cespitose culms and short ascending stolons. The lowest bract does not exceed the inflorescence, the lower sheaths are nearly if not entirely smooth, and the foliage is much less rough than in its eastern relatives.

More common in the same region is a much larger plant which has often been distributed as *Carex acutina* Bailey. In it the lowest bract much exceeds the inflorescence and the lower sheaths are strongly hispidulous. This species seems not to have been described and accordingly I am now proposing it as *Carex egregia*.

The plants from the eastern parts of the Rocky Mountains called *Carex acutina* seem to be either forms of *Carex aquatilis* Wahl. (*C. variabilis* Bailey), having sharp pointed scales exceeding the perigynia, or species closely related to it. They are but distantly related to the genuine *Carex acutina*.

The species here treated are separable as follows:

Culms very densely cespitose, forming bogs; short ascending stolons or long horizontal stolons not conspicuously developed. *C. stricta.*

Culms loosely cespitose, in clumps or beds; short ascending stolons or long horizontal stolons freely developed.

Loosely cespitose; with short ascending stolons.

Perigynia broadly oval or suborbicular, inflated, brownish at maturity (eastern United States). *C. Haydeni.*

Perigynia narrower, plano-convex, not inflated (Oregon and Washington).

Lowest bract exceeded by inflorescence; lower sheaths smooth. *C. angustata.*

Lowest bract exceeding inflorescence; lower sheaths hispidulous. *C. egregia.*

Forming beds; long horizontal stolons numerous.

Lower sheaths filamentose; perigynia granular-roughened, green; culms slender to base; lower sheaths little septate-nodulose. *C. strictior.*

Lower sheaths not filamentose; perigynia granular-roughened towards apex only, straw-colored; culms stout at base; lower sheaths strongly septate-nodulose. *C. Emoryi.*

CAREX STRICTA Lam. Encycl. 3: 387. 1789

"*Carex acuta* L." Muhl. Descr. Gram. 263. 1817.
Carex virginiana Smith, Rees' Cycl. 7 sp. 100. 1819.
Carex commutata J. Gay, Ann. Sci. Nat. II. 11: 198. 1839.
Carex Kelvingtoniana Steud. Syn. Pl. Cyp. 215. 1855.
Carex virginica Steud. Syn. Pl. Cyp. 217. 1855.
Carex tenuispica Boeckl. Flora 39: 225. 1856.
Carex tristicha Boeckl. Flora 41: 651. 1858.
Carex xerocarpa S. H. Wright, Am. Journ. Sci. II. 13: 334. 1866.
Carex angustata var. *α typica* and var. *β* (in great part) Boott, Ill. Car. 4: 173. *pl. 586, f. 1, 587.* 1867. Not *C. angustata* Boott; Hooker Fl. Bor. Am. 2: 218. 1867.
Carex angustata var. *xerocarpa* Bailey, Carex Cat. 1884.
Carex stricta var. *angustata* Bailey; A. Gray, Man. Ed. 6, 600. 1890.
Carex stricta xerocarpa Britton, Bull. Torrey Club 22: 222. 1895.

Growing in very dense tussocks, the culms aphyllopodic, 3–10 dm. high, slender, strict, exceeding leaves, very rough on the sharp angles, the faces concave, strongly filamentose and brownish or light purplish brown at base, the basal sheaths subcarinate. Leaves with well-developed blades three to five to a fertile culm, on lower fourth, often somewhat clustered, the sheaths slightly hispidulous, tight, hyaline and often brownish tinged opposite the blades, the blades 1.5–3 mm. wide, usually 1–3 dm. long, stiffish, deep green, the margins revolute, but blade itself channeled and keeled towards base, strongly roughened. Principal staminate spike usually one (with one or two smaller sessile ones near its base), erect, peduncled, 2–4 cm. long, 2.5 mm. wide, the scales oblong-obovate, obtuse, light reddish brown with lighter center and hyaline margins. Pistillate spikes usually two or three, erect, sessile, or lower slightly peduncled, more or less strongly separate, the upper often staminate above, the better developed 2–6 cm. long, 3–5 mm. wide, the perigynia closely arranged in several ranks (or spikes at times somewhat attenuate below);

bracts sheathless, their auricles inconspicuous, slightly dark-colored, the lower bract 1.5–3 mm. wide, shorter than inflorescence; the upper reduced. Scales variable, oblong-obovate to lanceolate, obtuse to acuminate, reddish, with lighter center and narrow hyaline margins, narrower and usually rather shorter than perigynia, appressed. Perigynia broadly to narrowly ovate, closely enveloping achene, plano-convex, not inflated, two-edged, granular-roughened, puncticulate, dark green, obscurely few-nerved dorsally, nerveless ventrally, 2.5 mm. long, 1.5 mm. wide, rounded and substipitate at base, short-tapering to the beakless or nearly so subentire whitish-tipped apex, the style short-exserted; achenes lenticular, broadly ovate, substipitate, 1.75 mm. long, 1.25 mm. wide; stigmas two.

SPECIMENS EXAMINED

MASSACHUSETTS: Cambridge, *Fernald*, June 10, 1891 (C.); Cambridge, *Underwood 2644*, May 9, 1891 (C.); Boston, *B. D. Greene* (C.); West Roxbury, *Forbes*, June 8, 1911 (K.M.).

RHODE ISLAND: Providence, *Olney*, June 8, 1871 (N. Y., C.); Providence, *Olney*, labeled *C. strictior* Dewey (C.).

NEW HAMPSHIRE: base of White Mountains, *Tuckerman* (C.).

NEW YORK: Bull's Head, Staten Island, *Britton*, June 2, 1889 (C.); Grant City, Staten Island, *Britton*, May 26, 1889 (C.); Suffern, *Schrank* (C.); West Hampton, *Delafield*, June 13, 1888 (C.); Junius, *Sartwell 54* (N. Y., C.); Prattsburgh, Steuben County, *Wright* (N. Y., C.), type of *C. xerocarpa* S. H. Wright; Philipstown, *Barratt* (C.); New York, *Torrey* (C.).

NEW JERSEY: Plainfield, *Tweedy*, June, 1884 (C.); Woodbridge, *Lighthipe*, May 3, 1890 (C.); Manchester, *Torrey* (C.); Pitman, Gloucester County, *Long 3425*, May 16, 1910 (P.); Farmingdale, *Long & Brown 3644*, May 28, 1910 (P.); Glassboro, Gloucester County, *Long 3360*, May 14, 1910 (P.); Delair, Camden County, *Long 3353*, May 10, 1910 (P.); Cape May Court House, *Long 7229*, June 1, 1912 (P.); Delanco, Burlington County, *Long 3466, 3467*, May 19, 1910 (P.); Cold Spring, Cape May County, *O. H. Brown*, June 26, 1911 (P.); Mickleton, *Crawford*, May 10, 1892 (P.); Kaighn's Point, Camden County, *MacElwee*, May 7, 1892 (P.); Batsto River, Burlington County, *Bassett 45*, May 25, 1912 (P.); Quinton, Salem County, *Long 3029*, April 22, 1910 (P.); Cranberry Lake, Sussex County, *Mackenzie 1294*, May 30, 1905 (K. M.);

Netcong, Morris County, *Mackenzie 3167*, June 21, 1908 (K. M.); Lakehurst, Ocean County, *Mackenzie 4546*, May 15, 1910 (K. M.); South Amboy, *Mackenzie 1223*, May 21, 1905 (K. M.); Charlotteburg, *Mackenzie 3083*, May 24, 1908 (K. M.); Chatham, *Mackenzie 174*, May 30, 1903 (K. M.); Greenwood Lake, *Mackenzie 2567*, May 19, 1907 (K. M.); Delaware, Warren County, *Mackenzie 5354*, May 10, 1913 (K. M.); Landisville, *Gross*, 1872 (P.); Camden, *Boice*, May 16, 1878 (P.).

PENNSYLVANIA: West Chester, *Pennell 1333*, May 29, 1909 (P.); Frazier's bog, Montgomery County, *Long 3354, 3356*, May 12, 1910, and *3773*, June 1, 1910 (P.); Tullytown, *Crawford* (P.); Corning, Lehigh County, *Pretz 5422*, May 30, 1913 (P.); Willistown, Chester County, *Stone* (P.); East Nantmeal Township, Chester County, *Pennell 2817*, June 14, 1911 (P.); Oxford, *Crawford*, June 8, 1892 (P.); Williamson, Delaware County, *Pennell 3770*, June 23, 1912 (P).; Allentown, *Pretz 4703*, June 28, 1912 (P.); Tullytown, *Keller*, June 12, 1897 (P.); Nottingham, Chester County, *Pennell & Long 3700*, June 22, 1912 (P.); Chester County, *Pennell 3910*, June 27, 1912 (P.); Penn Valley, *Crawford*, May 7, 1899 (P.); Nockamixon, *Crawford*, June 30, 1893 (P.); Penn Valley, *Crawford*, June 1, 1899 (P.); York County, *Glatfelter*, May 30, 1895 (K. M.); Penn Valley, *Pretz*, June 30, 1899 (P.); Centre Square, *Brinton*, May 20, 1892 (P.); Nockamixon, *Crawford*, June 30, 1893 (P.); Chester County, *Pennell 1398*, May 30, 1909 (P.); Lancaster, *Carter*, May 24, 1904 (P.); Stacy's Hollow, *Wister 46*, June 3, 1862 (P).

DELAWARE: Ashland, *Commons*, June, 1865 (P.); Greenbank, *Commons*, May 26, 1879 (P.).

ILLINOIS: Canton (*C. xerocarpa* S. H. Wright).

TENNESSEE: Jackson, *Bain* 489, May 15, 1893 (C.).

CAREX HAYDENI Dewey, Am. Journ. Sci. II. **18**: 103. 1845

Carex β erecta Dewey, Am. Journ. Sci. **10**: 265. 1826.

"*Carex aperta* Boott" Carey; A. Gray, Man. 547. 1848.

Carex aperta var. *β* Boott, Ill. Car. **4**: 132. *pl. 426*. 1867.

Carex aperta var. *minor* Olney, Exsicc. V. 15. 1871.

Carex stricta var. *decora* Bailey, Bot. Gaz. **13**: 85. 1888.

Carex stricta var. *β Haydenii* Kükenth.; Engler, Pflanzenreich 4^{20}: 330. 1909.

Cespitose, the culms slender, 3 mm. thick near base, 5–10 dm. high, aphyllopodic, sharply triangular and strongly roughened on the angles above, usually much exceeding the leaves, the fertile slightly or not at all filamentose at base. Leaves with well-developed blades two to four to a fertile culm, on the lower fourth but not bunched, the sheaths papery and yellowish- or whitish-hyaline ventrally, smooth or nearly so, the blades flat with slightly revolute margins, about 2.5 mm. wide, usually 1–2 dm. long, very rough towards the apex; sterile culm leaves longer. Terminal spike stiminate (usually with an additional sessile smaller one at base), linear, 2–4 cm. long, 3 mm. wide, the scales oblong spatulate, obtuse to acutish, reddish brown with lighter center and hyaline margins. Pistillate spikes two or three, erect, sessile or nearly so, approximate or a little separate, linear, 1.5–3 cm. long, 4–5 mm. wide, occasionally staminate at apex, scarcely attenuate at base, the perigynia very numerous, in few rows, spreading-ascending; bracts sheathless without dark colored auricles, the lowest 2 mm. wide, normally exceeded by inflorescence; the upper much reduced. Scales ovate or lanceolate, long acuminate to acute, narrower than but strongly exceeding perigynia, from dark brown to straw color, with lighter center and hyaline margins. Perigynia light brownish at maturity, flattened biconvex, broadly oval to suborbicular, two-edged nerveless or obscurely few-nerved, 2–2.5 mm. long, 1.25–1.75 mm. wide, membranaceous and slightly inflated, puncticulate and resinous dotted, minutely granular towards apex, round-tapering at base and apex and abruptly very minutely (0.2 mm. long) beaked, the orifice hyaline, entire or emarginate. Achenes lenticular, substipitate, apiculate, yellowish, with orbicular faces, 1 mm. long; style exserted; stigmas two.

This species has in times past been confused with *Carex aperta* Boott, a phyllopodic species from the Columbia River region. Although frequently treated as a variety of *Carex stricta* Lam., one cannot help feeling that this is due to lack of knowledge of the two species. They are really thoroughly distinct species, and I have seen no evidence of any tendency to intergrade.

SPECIMENS EXAMINED

NEW BRUNSWICK: Bathurst, *Fowler*, August 4, 1874 (N. Y.).

MAINE: Bangor, *Knight*, June 27, 1905 (K. M.); Bangor, *Mackenzie 3188*, July 3, 1908 (K. M.); Orono, *Harvey*, August, 1891 (N. Y.); Orono, *Fernald*, June 28, 1890 (C.); St. Francis, *Fernald 135*, August 5, 1893 (C.).

NEW HAMPSHIRE: Keene, *Gilbert*, June 11, 1877 (N. Y.).

MASSACHUSETTS: Dedham, *Forbes*, June 15, 1904, and June 9, 1914 (K. M.); Waverley, *W. Boott*, June 30, 1853 (N. Y.); "Mass.", *Davis* (C.).

RHODE ISLAND: *Olney* (C.).

NEW YORK: North Elba, *Peck* (N. Y.); Amherst, *Sartwell* (N. Y.).

NEW JERSEY: Lawrence, Mercer County, *S. Brown*, May 28, 29, 1904 (P.).

PENNSYLVANIA: Sellersville, Bucks County, *Pollard*, June 2, 1899 (K. M.); Sellersville, *Pretz*, June, 1883, May 16, 1896, and June, 1899 (P.); Plumsteadville, "*J.C.M.*", June, 1866 (P.).

ILLINOIS: Fountaindale, *Bebb*, 1870 (N. Y.); "Ill." *Vasey* (N. Y., C.).

MINNESOTA: Milaca, *Sheldon*, June, 1892 (C.); Nichols, *Sheldon*, June, 1892 (C.).

IOWA: Fayette, *Fink*, June, 1895 (N. Y.); St. Petersburg, *Parry* (C.).

MISSOURI: Lake City, Jackson County, *Mackenzie*, May 23, 1897 (K. M.).

NEBRASKA: "Nebraska Ter.", apparently duplicate of type (C.).

CAREX ANGUSTATA Boott; Hooker, Pl. Bor. Am. **2**: 218. 1840

Carex angustata Boott (in part), Ill. Car. **4**: 173. *pl. 586, f. 2.* 1867.

Carex acuta Bailey, Proc. Am. Acad. **22**: 86. 1886.

Carex acutina Bailey, Mem. Torrey Club 1: 52. 1889. Not "*Carex acutina* Bailey", Holm. Am. Journ. Sci. **16**: 34; or Kükenthal; Engler, Pflanzenreich 4^{20}: 319.

Loosely cespitose, with short ascending stolons covered with brown scales, the culms 3–6 dm. high, strongly aphyllopodic, slender, 3–4 mm. wide at base, 1.5 mm. above, exceeding the leaves, roughened above on the angles, brownish reddened and more or less filamentose at base. Leaves with well-developed blades usually three to five to a fertile culm, on the lower third, the blades light green ascending, flat to base with slightly revolute margins, smoothish beneath, 2.5–3 mm. wide, 1–4 dm. long, much roughened towards the attenuate apex, the sheaths smooth, membranous, easily breaking and slightly yellowish tinged ventrally. Staminate spike usually one, from little to strongly rough-peduncled, 2.5–5 cm. long, 3–5 mm. wide, the scales oblong-

obovate, obtuse, brownish-black with lighter center and slightly hyaline margins. Pistillate spikes three to five, erect, more or less strongly separate, the upper sessile, the lower short-peduncled, linear-cylindric, 2–4 cm. long, 3.5–5 mm. wide, the upper especially often staminate at apex, the lower slightly attenuate at base, the numerous perigynia ascending, closely packed in several ranks; lower bract leaflet-like, shorter than or sometimes nearly equalling inflorescence, sheathless; upper bracts shorter; auricles often darkened, the upper at least dilated. Scales oblong-ovate to lanceolate, obtusish to acuminate, narrower and from somewhat shorter to somewhat longer than perigynia, blackish with lighter center and slightly hyaline apex. Perigynia straw-colored, obovoid or oval, sessile or nearly so, two-edged plano-convex, finely many-nerved or nerveless when young, 3 mm. long, 1.5 mm. wide, glandular-puncticulate, slightly granular towards apex, not serrulate, round-tapering at base, abruptly apiculate, beaked, the beak 0.25 mm. long, with entire black-tipped orifice. Achenes lenticular, sessile, with obovate faces, 1.5 mm. long; stigmas two.

SPECIMENS EXAMINED

OREGON: Deschutes River, *Howell 935*, May 9, 1885 (N. Y., H.); Sauvie's Island, *Howell*, May 15, 1886 (N. Y.); "Oregon" 1883 (H.).

The original specimens of *Carex angustata* Boott were collected along the Columbia River in Oregon or Washington by Scouler and Tolmie. Later Dr. Boott, failing to notice that these specimens represented a different species than the eastern *Carex stricta* Lam., applied the name *Carex angustata* to the eastern plant. His reason for not taking up the name *Carex stricta* Lam. was that there was a common European species known as *Carex stricta* Good., and he believed that this name having come into common use should not be superseded by *Carex stricta* Lam., even though the latter was the earlier published name. His views on this point have, however, not prevailed, but later botanists in taking up the name *Carex stricta* Lam. have continued the confusion by tacking on the name *Carex angustata* to it as a slender-spiked variety, and have disregarded the real identity of this species.

Carex acutina Bailey has also been the source of much unnecessary confusion. The original comparison was with the European *Carex acuta*, an aphyllopodic species, and the original

specimens collected by Howell quite justify such a comparison. Later botanists have created confusion by applying the name to certain phyllopodic species related to *Carex aquatilis* Wahl. More justifiable was the confusion with the species immediately hereafter described.

Carex egregia sp. nov.

Loosely cespitose and short stoloniferous from slender creeping rootstocks, the culms 4.5–9 dm. high, 4.5 mm. wide at base, 1.5 mm. wide below spikes, slender but erect, sharply triangular with concave sides, slightly roughened above, exceeding leaves, strongly purplish tinged at base, aphyllopodic. Leaves with well-developed blades three or four to a fertile culm, on lower fourth, somewhat bunched, the blades flat to base with revolute margins, roughened towards apex, 2–3 mm. wide, usually 1–3 dm. long, the sheaths his-pidulous, little carinate and sparingly septate-nodulose dorsally, and brownish tinged ventrally. Terminal spike staminate, stalked, 4 cm. long, 5 mm. wide, the scales obovate, obtuse, purplish black with white midvein not extending to apex. Lateral spikes four or five, the upper one or two small, staminate, the lower two to four pistillate (often staminate at apex), more or less strongly separate, sessile or short-peduncled, 2.5–4.5 cm. long, 5 mm. wide, with very many appressed-ascending perigynia in several many rows. Lowest bract leaf-like, exceeding inflorescence, sheathless, dark tinged at base, the upper bracts reduced, not conspicuously dark-auricled. Scales lanceolate, acute, purplish black with white midvein, narrower and longer or shorter than perigynia. Perigynia plano-convex, obovate, 3 mm. long, 1.5 mm. wide, finely about three- to five-striate on both faces, brownish, puncticulate and granular-roughened, the margins sharp-nerved, not round, rounded and substipitate at base, rounded and abruptly minutely apiculate at apex, the orifice entire. Achenes lenticular, closely filling lower part of perigynia, brownish, 1.5 mm. long, substipitate, obovate; stigmas two.

Closely related to *Carex eurycarpa* Holm, a species with "rounded" perigynia, finely many-nerved on both faces and with more prominent emarginate beak. The type specimen was distributed as that species.

SPECIMENS EXAMINED

OREGON: Cascade Mountains, *Cusick 2989*, August 27, 1902 (N. Y., H.); Cycan Mountains, *Cusick 2757*, August 14, 1901

(H.); Silver Creek, Lake County, *Cusick 2729*, August 7, 1901 (N. Y., H.); Summit of the Cascades, *Cusick 2991*, August 14, 1902 (N. Y., H.).

WASHINGTON: Falcon Valley, *Suksdorf 5181*, July 15, 1905 (K. M., type).

IDAHO: Forks of St. Mary's River, *Leiberg 1174*, July 6, 1895 (N. Y.).

CAREX STRICTIOR Dewey; A. Wood, Class Book 582. 1845

"*Carex stricta* Good." Dewey, Am. Journ. Sci. **10**: 269. 1826.
Carex Watsoniana Steud. Syn. Pl. Cyp. 215. 1855.
Carex angustata var. γ and var. β (in small part) Boott, Ill. Car. **4**: 173. *pl. 588.* 1867.
Carex stricta var. *curtissima* Peck; Howe, Rep. N. Y. State Museum 15. 1895.

Cespitose, growing in beds (not in dense tussocks), freely long-stoloniferous, the culms aphyllopodic, 3.5–9 dm. high, erect, slender, sharply triangular, 3.5 mm. wide at base, 1.5 mm. above, very rough above, purplish tinged at base, exceeding leaves, the basal sheaths hispidulous, strongly filamentose. Leaves with well-developed blades three or four to a fertile culm, the blades at first glaucous-green or in age light green, revolute margined, flat to base, 2.5–3.5 mm. wide, mostly 2–4 dm. long, the margins very rough, the sheaths strongly yellowish-brown tinged ventrally. Terminal spike staminate, strongly peduncled, linear, 2–3 cm. long, 3 mm. wide, the scales oblong-obovate, obtuse, purplish-black with lighter center and narrowly hyaline margins. Lateral spikes mostly three, pistillate, approximate and sessile or nearly so; or the lowest often remote and slender long-peduncled, linear, 4–5 mm. wide, 1.5–3 cm. long, with very many ascending perigynia, closely (or at base more loosely) packed in several ranks. Lowest bract leaflet-like, about length of culm, sheathless; the upper much reduced. Scales lanceolate or oblong-lanceolate, obtuse or acute, narrower and from slightly shorter to slightly longer than perigynia, purplish black or in age deep reddish brown with lighter center. Perigynia plano-convex, ovate, closely enveloping achene, light green, granular-roughened, puncticulate, reddish dotted, obscurely few-nerved, 2.25 mm. long, 1.5 mm. wide, two-edged, not serrulate, rounded and sessile at base, abruptly very minutely beaked, the orifice entire. Achenes lenticular, light brown, oblong-obovate, 1.75 mm. long, 1.25 mm. wide, minutely apiculate, the short slender style tardily deciduous; stigmas two.

The original description of this species by Dewey in Wood's Class Book is not satisfactory and it is easy to understand why subsequent botanists have failed to recognize the plant. It is as follows:

"Staminate spikes 1–2 with oblong and blackish acutish glumes; pistillate spikes 2–3, cylindric, staminate above, and hence acutish, lowest short pedunculate; perig. ovate, compressed, acute, glabrous, entire at the orifice, early falling off, glabrous, a little longer than the oblong and acute glume; st. a foot and more high, triquetrous and rough on the angles, with reticulated filaments connecting the leaves towards the base; lvs. erect, close; whole plant glaucous, except the spikes.—Wet places, common."

In 1826, however, in his articles on caricography he had described two closely related plants, one of which he called *C. acuta*, and the other of which he called "*Carex stricta* Good." His description of the latter (Am. Journ. Sci. **10**: 269) is an excellent description of the plant I am now treating as *Carex strictior* Dewey. After a thorough technical description, in which he speaks of the nearly black pistillate scales and filamentose sheaths, he says, "color of the plants, except the spikes glaucous green," and ends up with the following:

"This species, found in England and Sweden, was first recognized in our country, by Mr. Schweinitz. It has probably been confounded with C. acuta, which it much resembles. There can be no doubt however that it is a distinct species. Though it grows in similar situations with C. acuta, it does not form a *bog*, but spreads over the surface of the marsh. It differs from that species too in its color, in the appearance of its spikes, in its more stiff and erect form and in its fruit being *caducous*" [italics Dewey's].

It will be noted that the points emphasized by him are the same points emphasized in his description of *Carex strictior* (*supra*), namely, color of plant, "more stiff" form, "strictior," and "caducous" or "early falling off" perigynia. His *Carex strictior* grows in wet places and no mention is made of its growing in bogs (i. e., dense tufts).

Again while he included a description of *Carex stricta* in Wood's Class Book he did not emphasize any of the points emphasized by him in 1826, and he speaks of the plant being found in "wet

places, as bogs." What then apparently happened is that in the interval between 1826 and 1843 Dewey found out that his original "*Carex stricta* Good." was different from that European species. So he made up a new name to apply to his plant, namely *C. strictior* Dewey. And at the same time he applied the name *Carex stricta* to our common densely tufted species.

As bearing out these views as to the identity of *Carex strictior* it is to be noted that in the 1863 edition of Wood's Class-Book Dewey added to his description of *C. strictior*, the words, "Nearer *C. caespitosa* than *C. stricta*," his *Carex caespitosa* being the strongly stoloniferous, bed-forming *Carex Goodenovii*.

Dewey's own herbarium does not aid very much. It contains four specimens kindly lent me by Professor Fernald. Three of these, collected and distributed by Sartwell, represent the species I take to be *C. strictior*. The fourth specimen collected by Olney is a specimen of *Carex stricta* Lam. Similar specimens collected by Sartwell and Olney are in the Torrey herbarium at the New York Botanical Garden.

The fact that this species is distinct from *Carex stricta* has been noted by a number of botanists. Thus, on a specimen in the Philadelphia Academy collected in 1892 by Mr. Benjamin Heritage, we find him noting it as "a form that does not grow in tufts, but is stoloniferous." Mr. Bayard Long in 1910 collected it at Frazier's Bog, near Philadelphia, noting its difference in habit of growth; and Mr. E. P. Bicknell and Dr. Wm. H. Wiegmann have both collected it around New York as *Carex aquatilis*, which in manner of growth it much resembles. And correspondence with Dr. E. H. Eames and Mr. F. F. Forbes has resulted in specimens from them both from plants which they had previously seen were distinct from *Carex stricta*.

The specimens listed below are to be referred to this species. Some are so poor that their identification has been difficult.

SPECIMENS EXAMINED

MAINE: Veazie, *Knight*, July 15, 1905 (K. M.); Fort Kent, *Mackenzie 3436*, *3424*, *3427*, July 11, 1908 (K. M.); *3663*, July 23, 1908 (K. M.); Somesville, Mt. Desert Island, *Rand*, June 24, 1891 (C.); Foxcroft, *Fernald 231*, June 25, 1895 (C.).

NEW HAMPSHIRE: Muik Pond, Lisbon, *Graves*, June 9, 1893 (C.); base of White Mountains, *Oakes* (N. Y., C.).

MASSACHUSETTS: Chapman, no data (C.); Williamstown, no data (C.); Tewksbury, *Forbes*, June 7, 1911 (K. M.).

RHODE ISLAND: Providence, *Olney*, June 8, 1871 (K. M.); Cat Swamp, Providence, *Collins*, June 19, 1892 (C.).

CONNECTICUT: Easton, *Eames 8743*, June 3, 1914 (K. M.).

ONTARIO: Thedford, Lambton County, *Dodge*, June 22, 1911 (K. M.).

NEW YORK: Penn Yan, *Sartwell* (one in N. Y. Herb. and three specimens in Dewey Herb. and one in W. Boott Herb., H.); Van Cortlandt, *Bicknell*, June 1, 1890 (C.); Wellesley Island, Jefferson County, *Robinson & Maxon 28*, June 28, 1902 (N. Y.); *Torrey*, no data (C.); Junius, *Sartwell 55* (N. Y.); Junius, *Sartwell*, labeled "*Carex aquatilis*" (C.); N. Y., *Crawe* (C.); Litchfield, *Hunt*, June 1873 (N. Y.); Herkimer County, *Haberer*, June 24, 1882 (C.).

NEW JERSEY: Mickleton, *Heritage*, June 5, 1892 (P.); New Egypt, *J. H. Grove*, May 21, 1905 (P.); Repaupo, *Crawford*, June 15, 1893 (P.); Lindenwold, *Githens*, June 28, 1902 (P.); Lawrence, *Mackenzie 5868, 5874*, May 31, 1914 (K. M.); Oak Ridge, *Mackenzie 3185, 3182, 3186*, June 28, 1908 (K. M.); Hoboken, *A. Brown*, 1877 (C.); "New Jersey" *Knieskern 57*, as *Carex salina* Wahl.? (C.); Manchester, *Knieskern* (C.).

PENNSYLVANIA: Mountainville, Lehigh County, *Pretz 319*, May 30, 1907, *429*, June 22, 1907 (P.); Springfield, Bucks County, *Pretz*, June 1886 (P.); "Marshall road" *C. E. Smith*, May 21 (P.); Penn Valley, Bucks County, *Crawford*, June 1, 1899 (P.); Allentown, *Pretz 49*, May 18, 1901, *5503*, June 17, 1913, *1238*, June 11, 1908 (P.); Sellersville, *Crawford*, June 11, 1899 (P.); Slatington, *Bachman 2085*, May 13, 1911 (P.); Frazier's Bog, Willow Grove, Montgomery County, *Long 3771, 3767, 3768, 3774, 3769*, June 1, 1910, *9434*, June 7, 1914, *3355*, May 12, 1910; Byberry, *Martindale*, June 1865 (P.); Tinicum Meadows, Delaware County, *B. H. Smith*, May 30, 1898 (P.); Lowhill, Lehigh County, *Pretz 4677*, June 23, 1912 (P.); Lehigh County, *Krout;* Easton, *Porter*, July 8, 1890 (C.); Long Pond, Monroe County, *Britton*, June 24, 1895 (C.); Bucks County, *Pretz*, May 30, 1899 (P.).

DELAWARE: Centreville, *Commons*, May, 1864, and June 14 1868 (P.); Greenbank, *Commons*, May 27, 1879, and May 1, 1882 (P.); May 26, 1879 (var. *curtissima*) (P.).

MARYLAND: Conowingo, Cecil County, *Bartram & Long 1250*, June 1, 1913 (P.).

NORTH CAROLINA: Hendersonville, *Biltmore Herb. 1818a*, May 27, 1898 (K. M., N. Y.); Highlands, *Biltmore Herb. 4990b*, June 5, 1897 (N. Y.); Mitchell County, *Ashe*, May (N. Y.); Macon County, Buckley (C.).

TENNESSEE: Thompson's, *Ruth 978*, May, 1894 (N. Y.).

MICHIGAN: Port Huron, *Dodge*, May 30, 1911 (K. M.); Grand Rapids, *Miss Cole*, May 16, 1898 (K. M.); Emerson, Chippewa County, *Dodge*, June 16, 1914 (K. M.); Buchanan, *Deam 14195*, May 29, 1914 (K. M.); Vermilion, Chippewa County, *Dodge*, June 21, 1914 (K. M.); Olivet, *McClatchie*, May 24, 1888 (N. Y.); Lake Superior, *Pitcher* (C.); Hubbardston, *Wheeler*, June 25, 1890 (C.).

OHIO: London, *Sharp*, 1910 (N. Y.); "ad ripas Ohionis," *Lesquereux 551* (N. Y.).

WISCONSIN: Milwaukee, *Hasse*, May 27, 1882, and June 3, 1883 (N. Y.).

ILLINOIS: Winnebago County, *Bebb*, 1870 (C.); Chicago, *Moffat 88*, June 24, 1893 (N. Y.).

IOWA: Charles City, *Arthur* (C.).

NEBRASKA: "Nebraska" no data (C.).

CAREX EMORYI Dewey, Bot. Mex. Bound. 230. 1858

Carex virginiana var. *elongata* Boeckl. Linnaea **40**: 432. 1876.

Carex stricta var. *Emoryi* Bailey, Proc. Am. Acad. **22**: 85. 1886.

Carex acuta var. Reverchon's distr. Texan Pl. 1407; Bailey, l. c. 1886.

"*Carex stricta* Lam." Mackenzie & Bush, Fl. Jackson Co. Mo. 49. 1902.

"*Carex stricta* var. *angustata* (Boott) Bailey", Mackenzie & Bush, l. c. 1902.

Carex milligrana Holm, Am. Journ. Sci. **17**: 311. 1904.

Loosely cespitose, growing in beds, with long slender root-stocks, the culms aphyllopodic, 4–10 dm. high, erect, 6–8 mm.

wide at base, slender, sharply triangular and from strongly roughened to nearly smooth above, exceeding leaves, purplish tinged at base, the basal sheaths smooth, not filamentose. Leaves with well-developed blades usually three or four to a fertile culm, on lower fourth, but not clustered, the blades light green, ascending, somewhat nodulose, flat to base with slightly revolute margins, much roughened towards apex, 3–5 mm. wide, 1.5–4 dm. long, the sheaths very membranaceous ventrally, slightly yellowish tinged. Terminal spike staminate, strongly peduncled, linear, 2–4.5 cm. long, 4 mm. wide, the scales oblong-spatulate, obtuse or acutish, brownish with broad lighter center and hyaline margins. Lateral spikes four to six, the upper one or two staminate, the lower pistillate or often staminate at apex, erect, sessile or the lower short-peduncled, linear, 2–10 cm. long, 4–6 mm. wide, with very many ascending perigynia closely (or at base more loosely) packed in several ranks. Lowest bract leaflet-like, from about equalling to exceeding culm, sheathless; the upper much reduced. Scales lanceolate, obtusish, short-acute or acuminate, scarcely 1 mm. wide, narrower and from somewhat shorter than to strongly exceeding perigynia, light or purplish brown with broad lighter center falling with the perigynia. Perigynia plano-convex, ovate or obovate, closely enveloping achene, at first light green, soon straw-colored, slightly granular-roughened towards apex, puncticulate, somewhat reddish dotted, few-nerved dorsally, 2–2.5 mm. long, 1.5–1.75 mm. wide, two-edged, not serrulate, rounded and sessile at base, abruptly apiculate-beaked, the orifice whitish, entire. Achenes lenticular, oblong-quadrate, substipitate, 1.5 mm. long, 1 mm. wide, minutely apiculate, the short slender style tardily deciduous; stigmas two.

SPECIMENS EXAMINED

NEW JERSEY: Scudders Falls, *Mackenzie 5062*, June 9, 1912 (K. M.); Red Bank, Gloucester County, *Parker*, June 6, 1872 (K. M., P.); Delaware, *Mackenzie 4998*, May 30, 1912 (K. M.); Crosswicks Creek, *Mackenzie 5809*, May 21, 1914 (K. M.); Coopers Creek, *Parker*, July 14, 1868 (P.); Camden, *Parker* (P., C.); Swedesboro, *Lippincott*, May 30, 1892 (P.).

PENNSYLVANIA: Bethlehem, *Schweinitz;* York Furnace, *Stone*, May 30, 1907 (P.); Penn Valley, *Crawford*, June 12, 1895 (P.); Tinicum, *Saunders*, May 20, 1898 (P.); Tinicum Township, *Saunders*, June 19, 1897 (P.); Penn Valley, Bucks County, *Crawford*, June 1, 1899 (P.); Kintnersville, *Van Pelt*, June 19, 1905

(P.); Narrowsville, *Lippincott*, May 30, 1893 (P.); Chester County, *Canby* (H.); Fort Washington, Montgomery County, *Long*, June 11, 1909 (P.).

DELAWARE: Hollyoak, *Commons*, June 6, 1866 (P.).

MARYLAND: Frederick County, *Aikin* (C.).

DISTRICT OF COLUMBIA: *Steele*, May 18, 1908, and May 12, 1902; *Vasey*, 188–.

INDIANA: Carmel, *Mrs. Deam 10548*, May 9, 1912 (K. M.); Cedarville, *Deam 14280*, June 14, 1914 (K. M.).

ILLINOIS: *J. Wolf*, no data (K. M.).

MANITOBA: Brandon, *Macoun 13357*, June 8, 1896 (N. Y.).

IOWA: Marshalltown, *Ball 381*, May 15, 1897 (K. M.); Council Bluffs, *Nicollet*, 1845 (C.).

MISSOURI: Greenwood, *Bush 6708*, May 20, 1912 (K. M., N. Y.); Monteer, *Bush 2896A*, May 17, 1905 (K. M.); Courtney, *Bush 6730*, May 28, 1912 (K. M.); Courtney, *Bush 6755, 6758*, June 2, 1912 (K. M.); Independence, *Bush 703*, May 23, 1894 (K. M., C.); Greenwood, *Mackenzie*, May 9, 1897 (K. M.); Buckner, *Bush 6762, 6776* (N. Y., K. M.), June 5, 1912 (K. M.); Lake City, *Mackenzie*, May 23, 1897 (K. M.); Sarcoxie, *Palmer 3706*, May 19, 1912 (N. Y.); Independence, *Bush*, June 3, 1888 (N. Y.); St. Louis, *Riehl 30*, June, 1838 (C.).

NORTH DAKOTA: Towner, McHenry County, *Lunell*, May 29, 1908, and June 12, 1913 (K. M.); Minot, Ward County, *Lunell*, July 7, 1907 (K. M., N. Y.); Ward County, *Haigh 224*, 1900 (N. Y.), June 24, 1908 (N. Y.).

SOUTH DAKOTA: Rosebud Creek, *E. J. Wallace*, July 2, 1896, type of *C. millegrana* Holm (K. M., N. Y.): Brookings, *Williams & Carter*, June 19, 1897 (K. M.); Sylvan Lake, Black Hills, *Rydberg 1085*, June, 1892 (N. Y.); Brookings, *Carter*, June 10, 1897 (N. Y.).

NEBRASKA: Ashland, *Williams*, May 1890 (K. M., N. Y.); Fort Niobrara, *Wilcox*, May, 1888 (C.).

KANSAS: Manhattan, May 16, 1889 (C.); Riley County, *Norton 553*, May 23, 1895 (N. Y.); Osborne City, *Shear 51*, May 26, 1894 (C).; Wichita, *Carleton*, May 9, 1888 (C.).

OKLAHOMA: Sapulpa, *Bush 1070*, May 2, 1895 (C.).

COLORADO: Fort Collins, *Marshall 2534*, June 12, 1899 (N. Y.); Fort Collins, *State Agr. Col. 2570*, June 7, 1898 (N. Y.).

TEXAS: Llano County, *Reverchon 1407*, May 1885 (K. M., N. Y.); Upper Rio Grande, *Bigelow*, Mexican Boundary Survey, duplicate of type (C.).

INDEX TO AMERICAN BOTANICAL LITERATURE

1912–1915

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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Copaifera yeguana sp. nov.

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Includes *Sabatia obtusata* sp. nov.

Blake, S. F. Two new Mexican amaranths. Jour. Bot. **53**: 103, 104. Ap 1915.

Amaranthus annectens and *A. lepturus*, spp. nov.

Blodgett, F. M. Further studies on the spread and control of hop mildew. N. Y. Agr. Exp. Sta. Bull. 395: 29–80. *pl. 1, 2 + f. 1, 2.* F 1915.

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Includes *Helminthosporium obclavatulum* sp. nov. from Brazil.

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Includes 18 new species in *Russula*.

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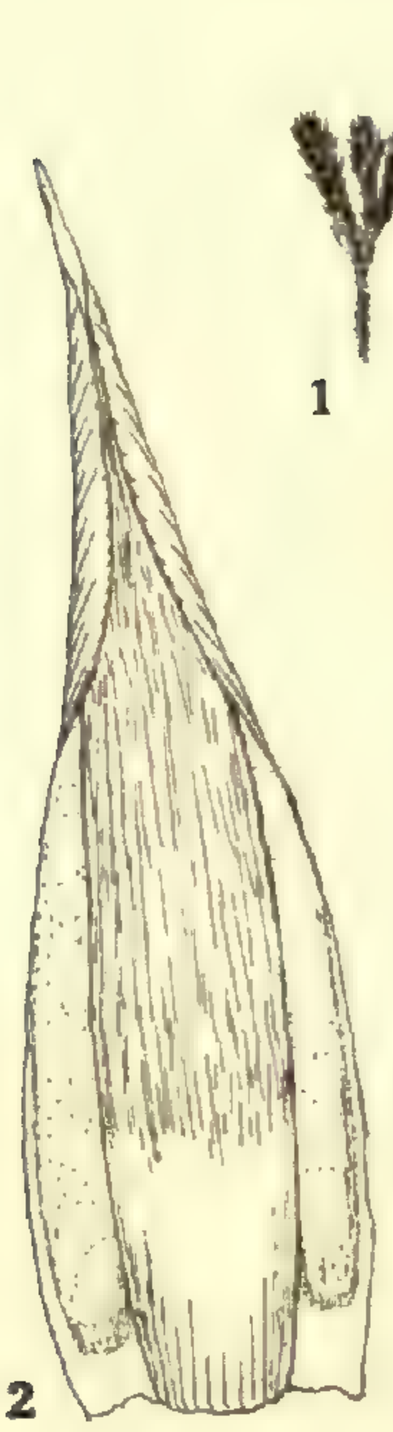
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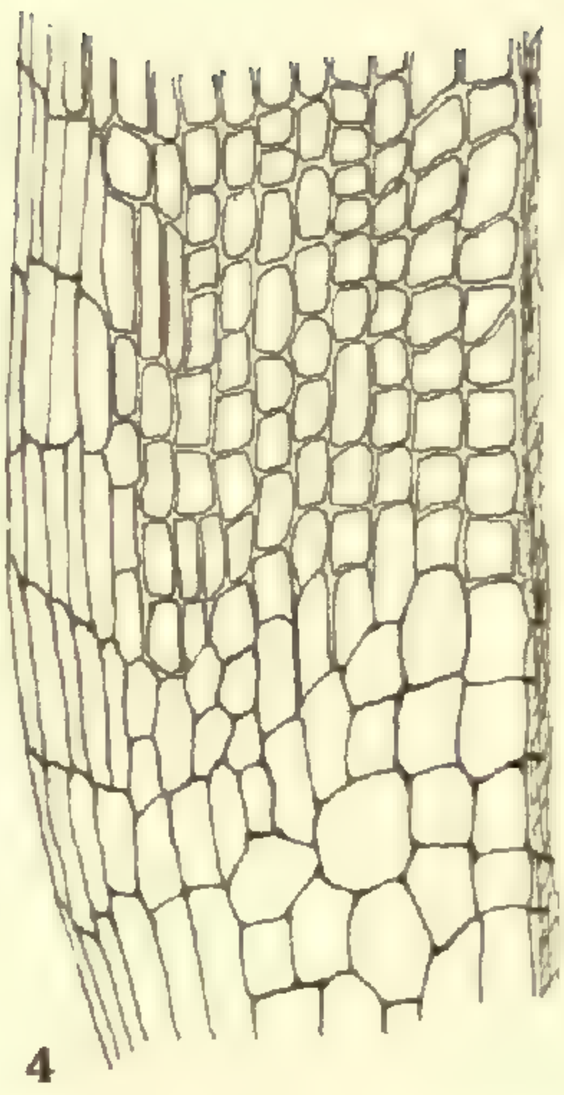
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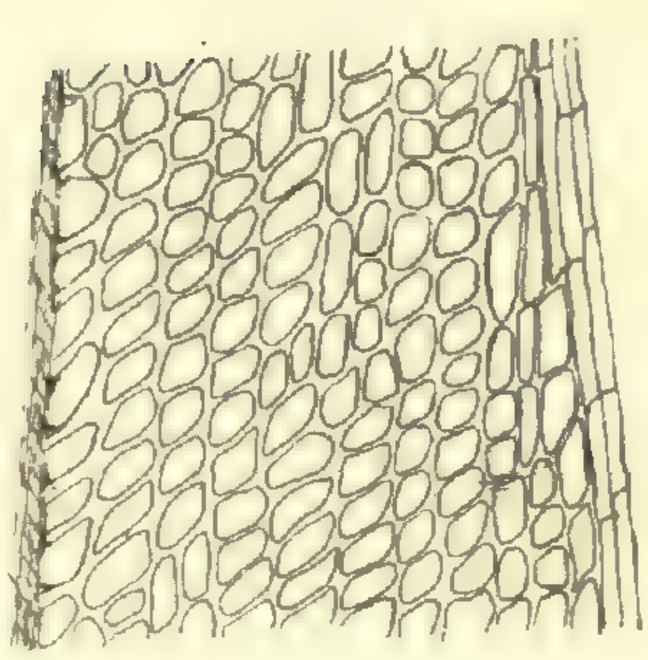
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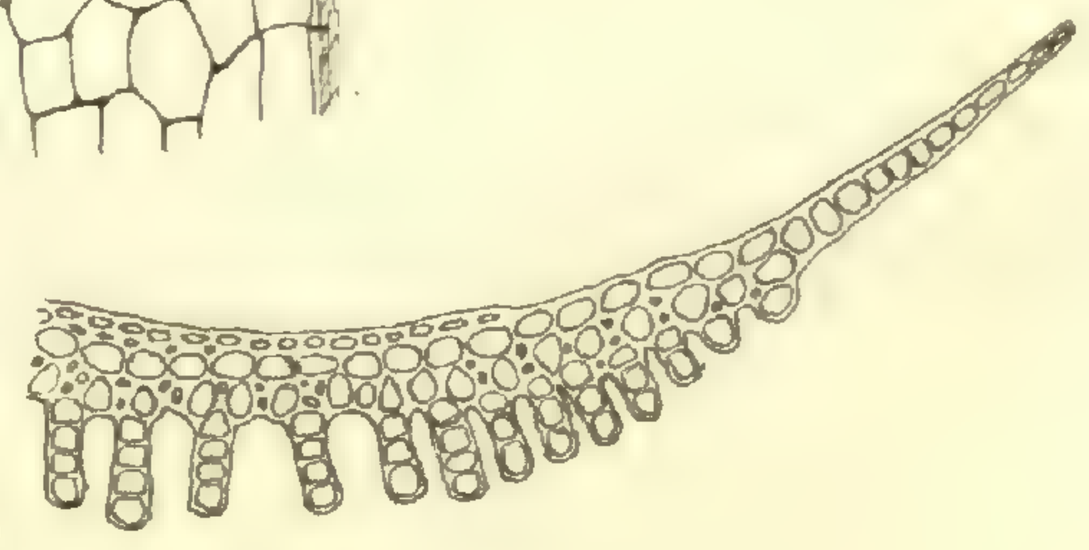
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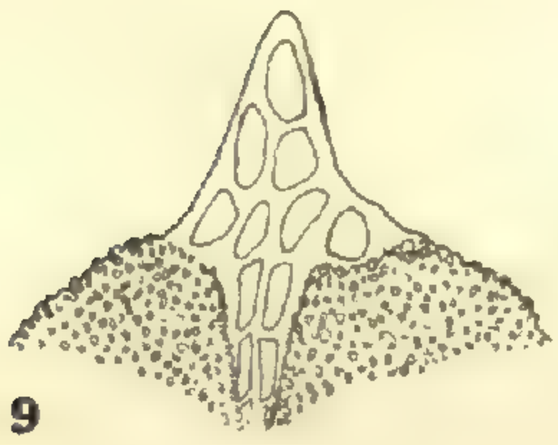
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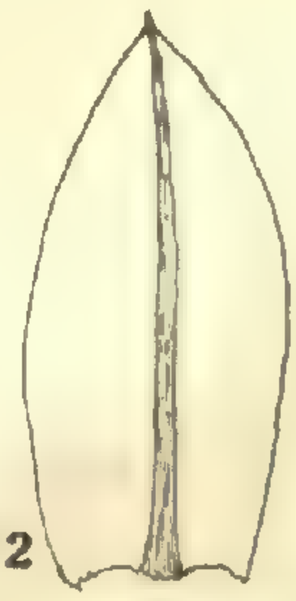
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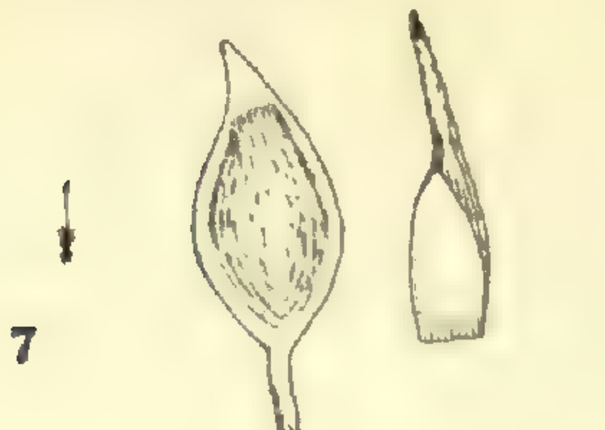
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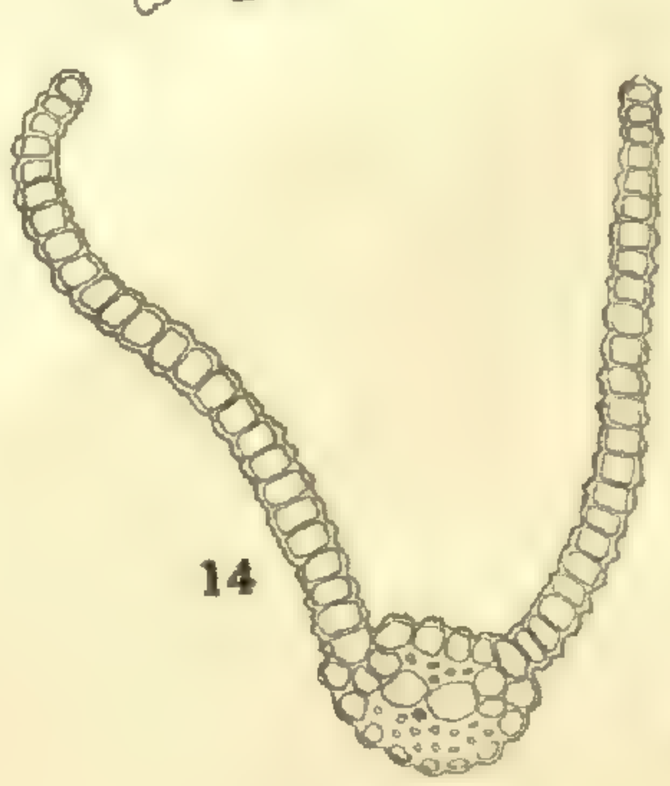
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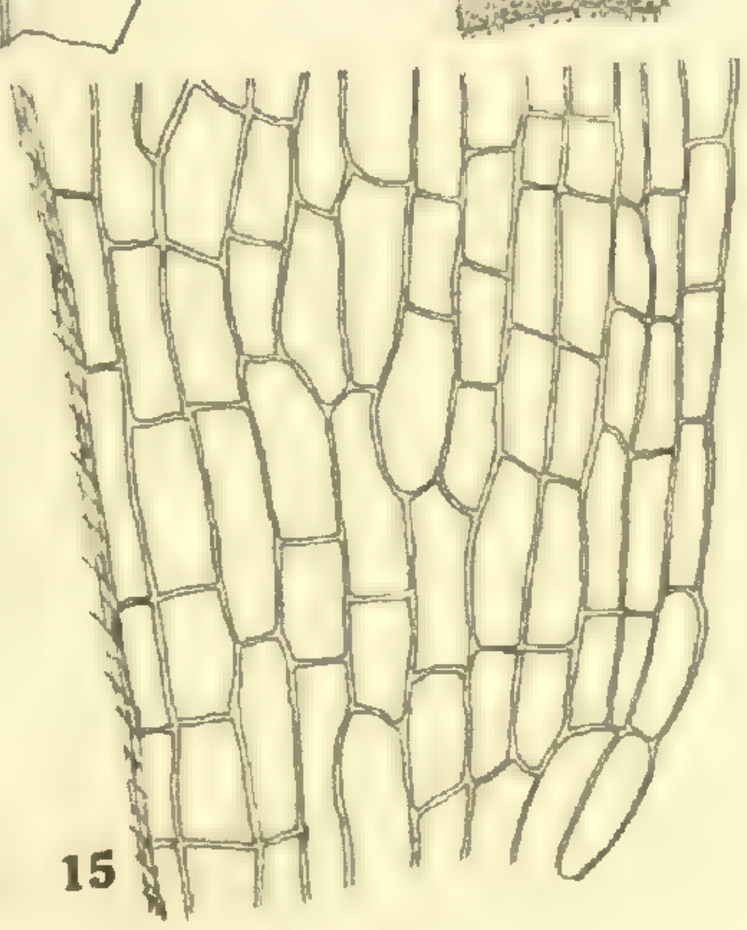
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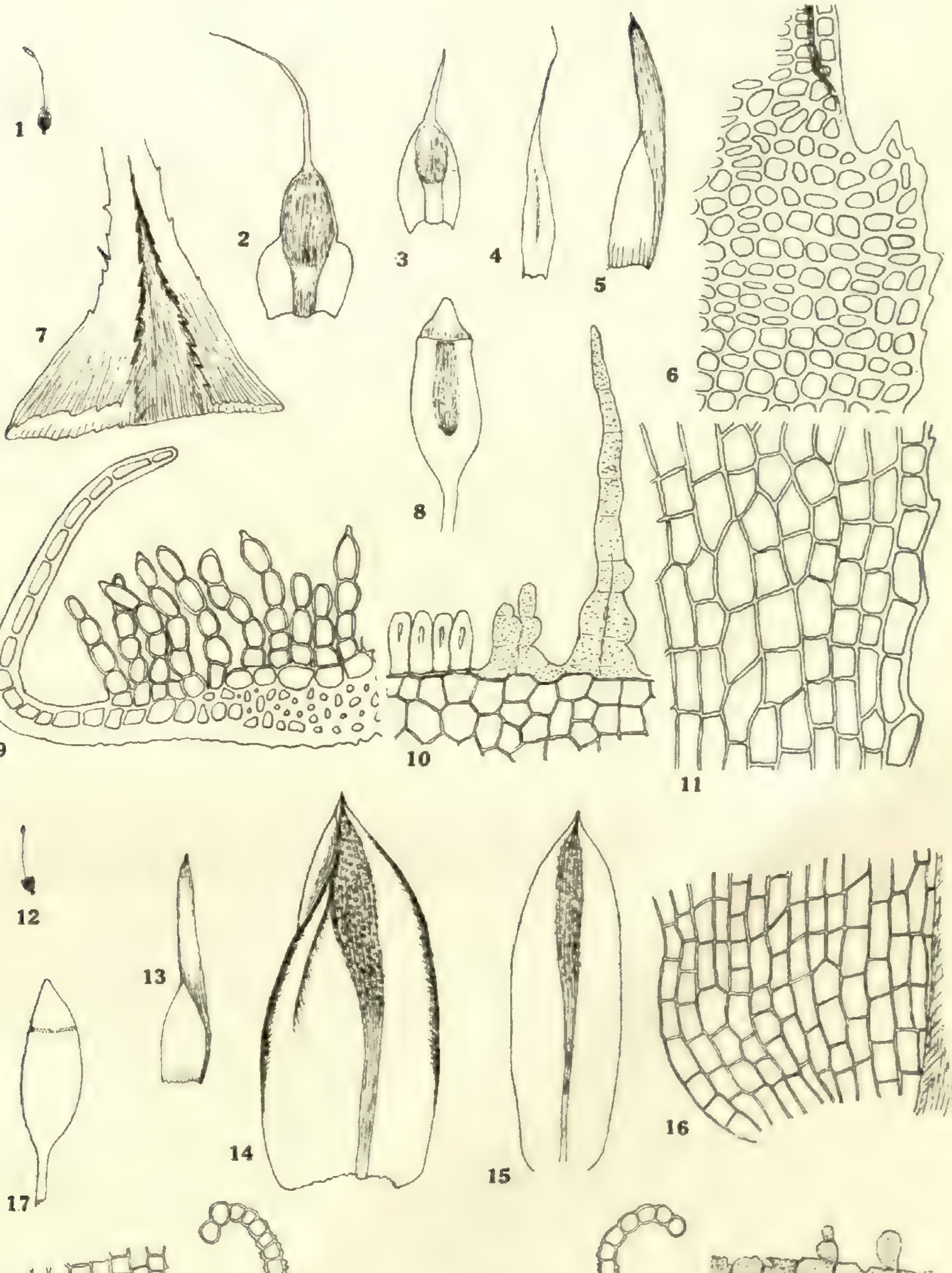
1–6. CAMPYLOPUS PERUVIANUS R. S. WILLIAMS
7–15. ASTOMUM CHILENSE R. S. WILLIAMS



I–II. PTEROGONEURUM ROSEAE R. S. WILLIAMS

12–20. CROSSIDIUM ROSEI R. S. WILLIAMS

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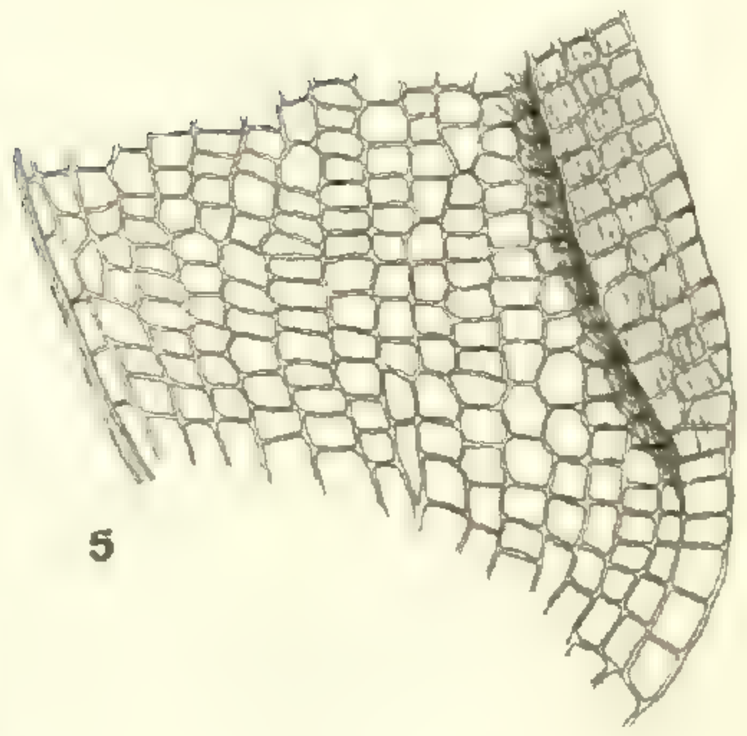
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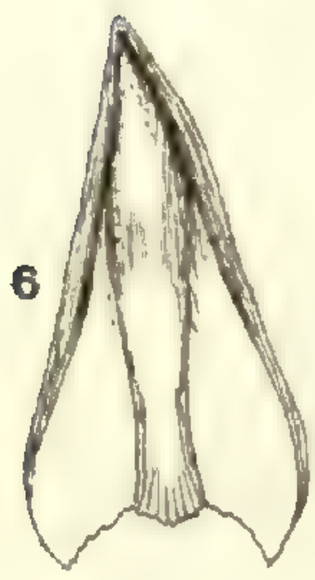
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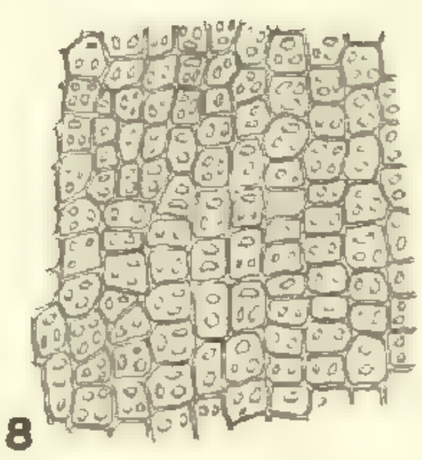
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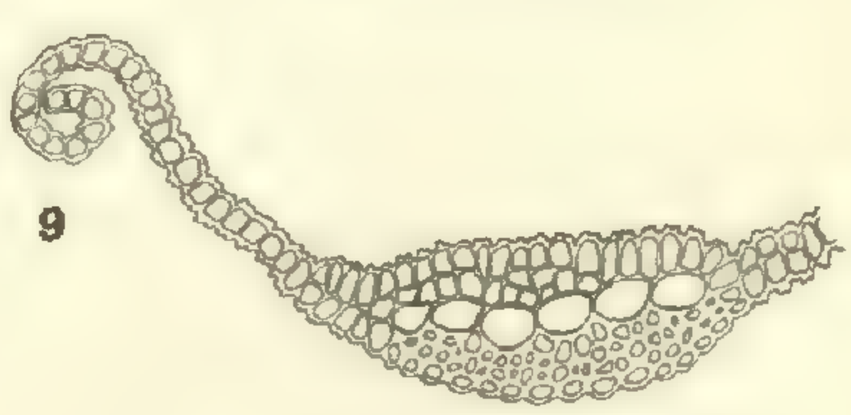
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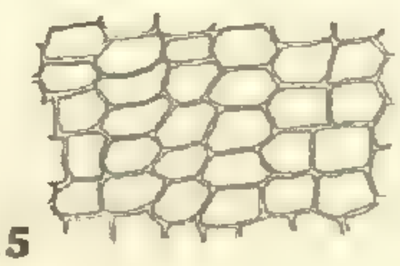
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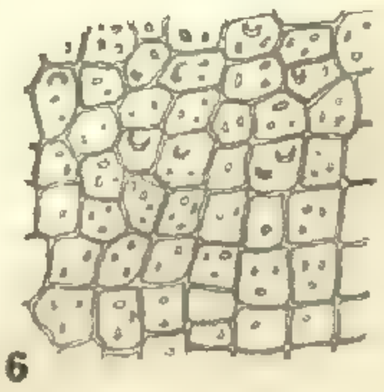
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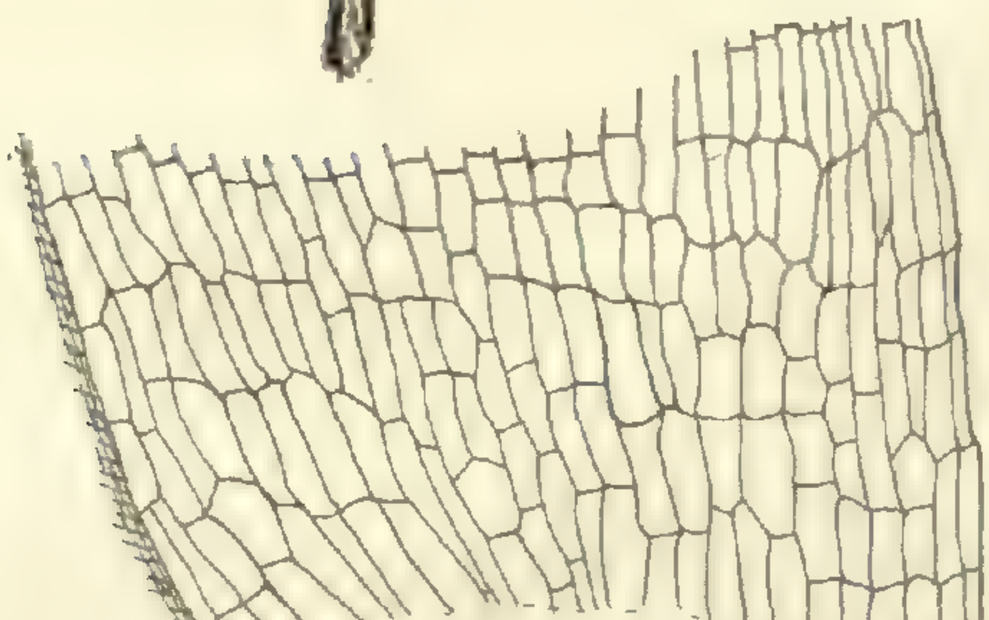
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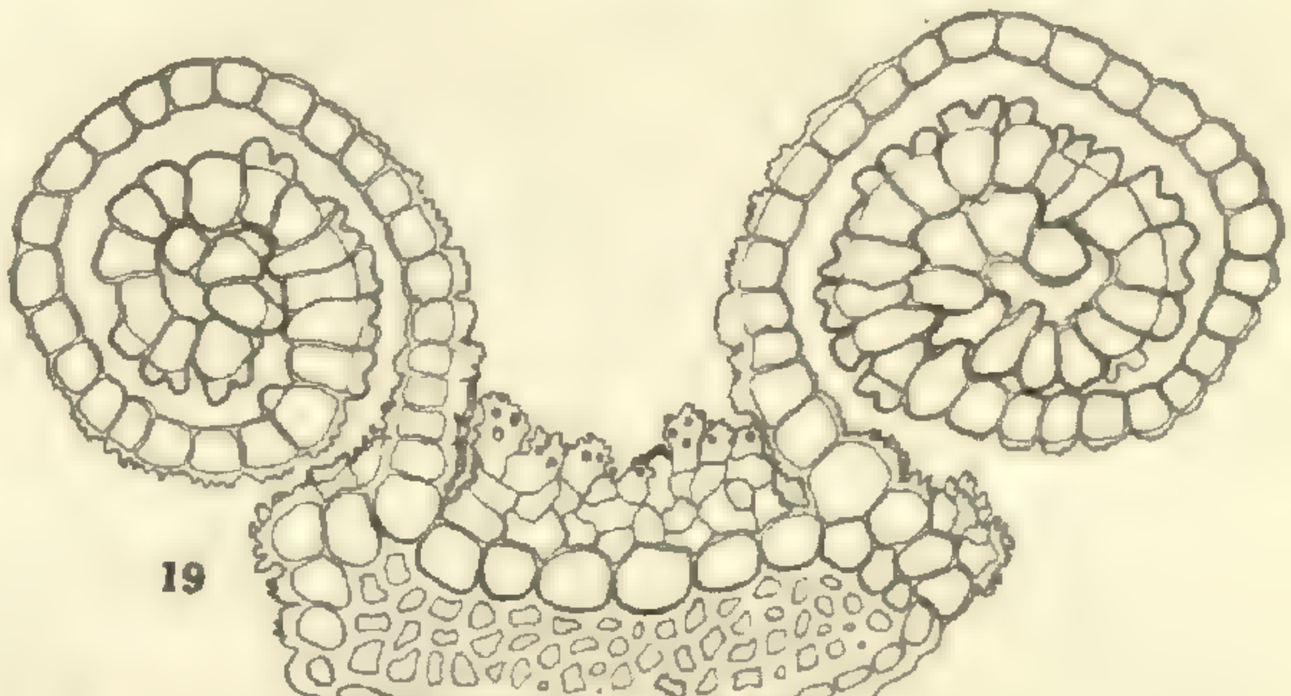
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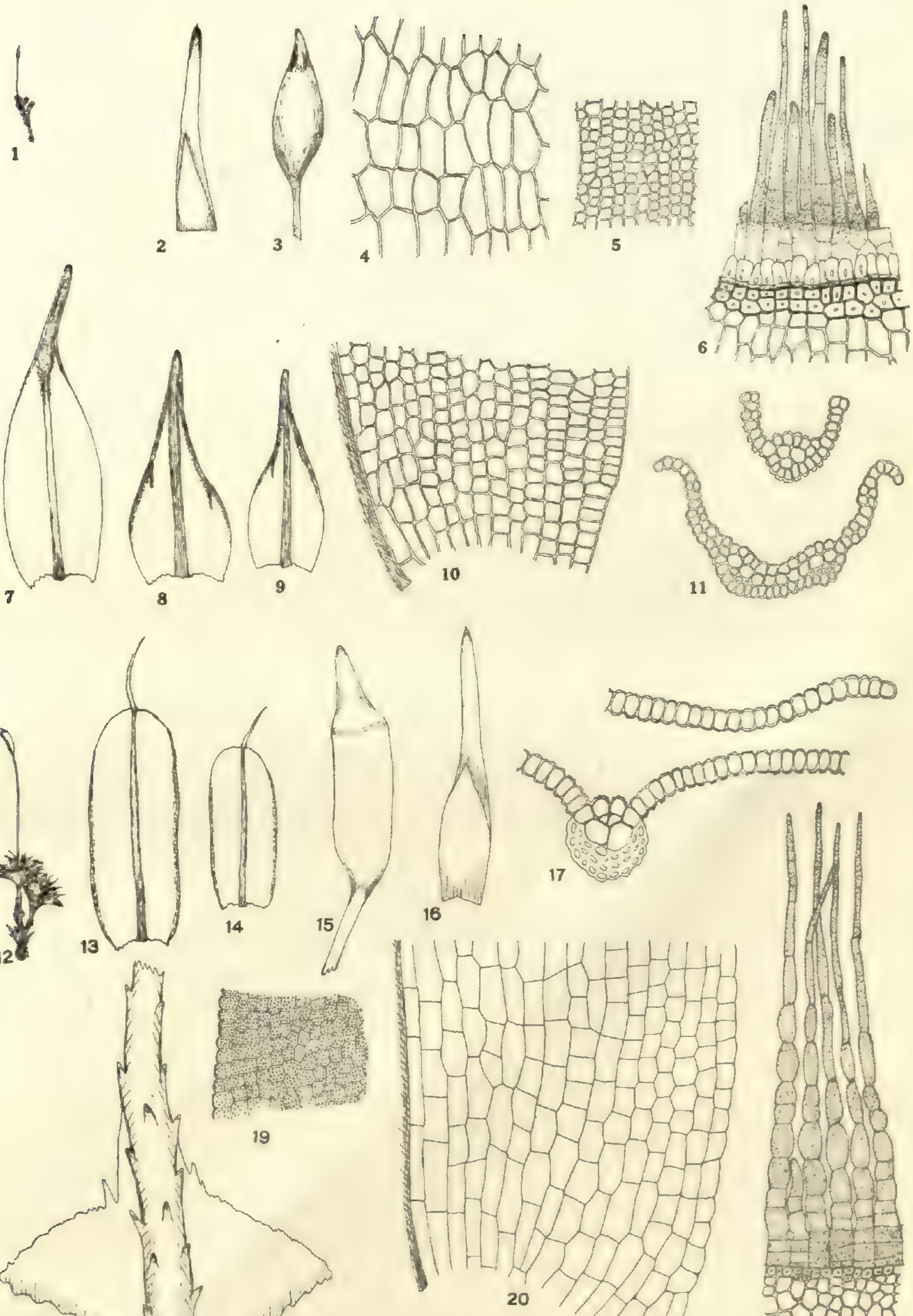
1–10. PSEUDOCROSSIDIUM CHILENSE R. S. WILLIAMS
11–19. PSEUDOCROSSIDIUM APICULATUM R. S. WILLIAMS



1–11. TORTULA MINUSCULA R. S. WILLIAMS
12–21. TORTULA LIMENSIS R. S. WILLIAMS

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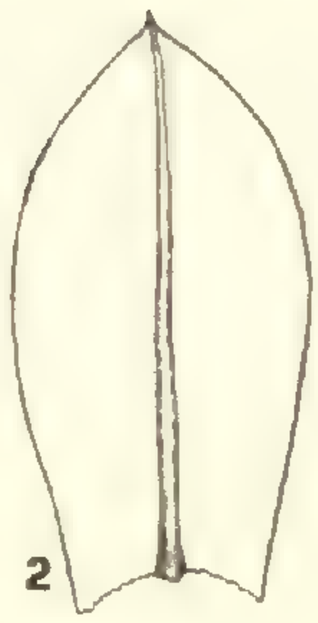
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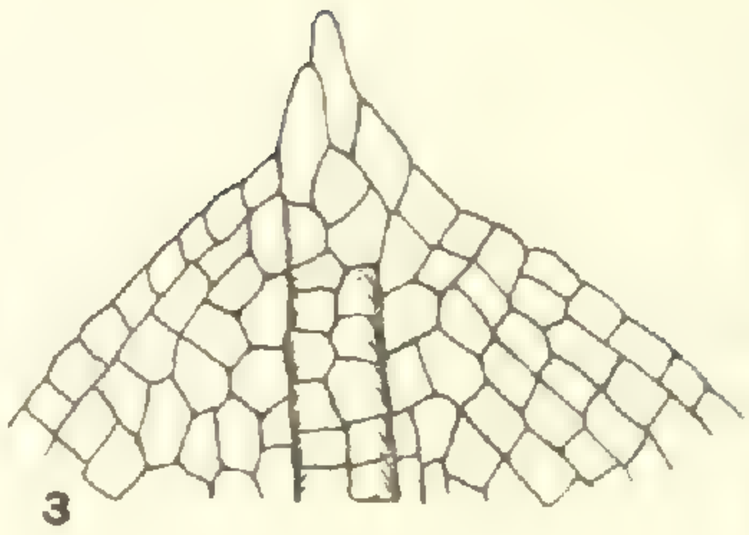
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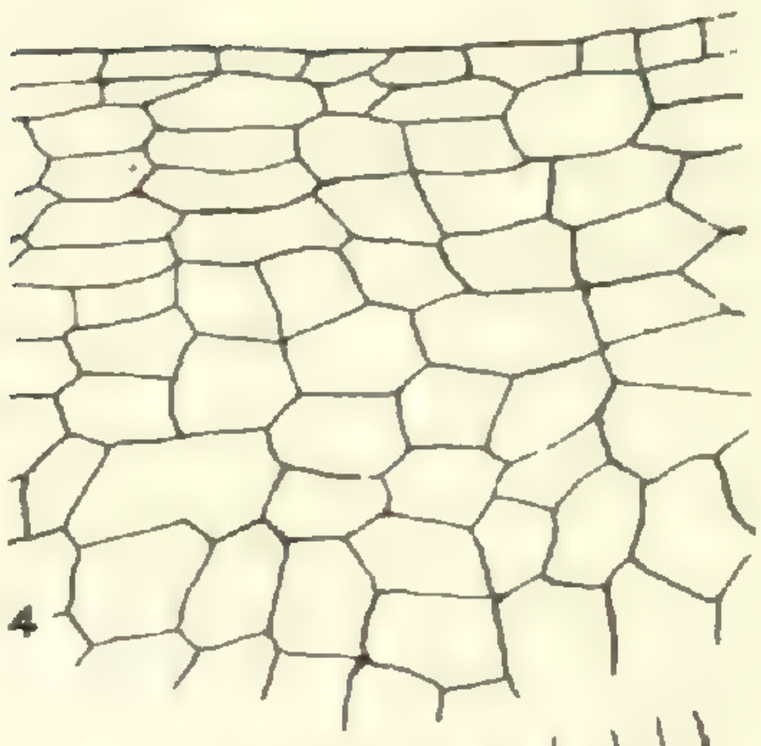
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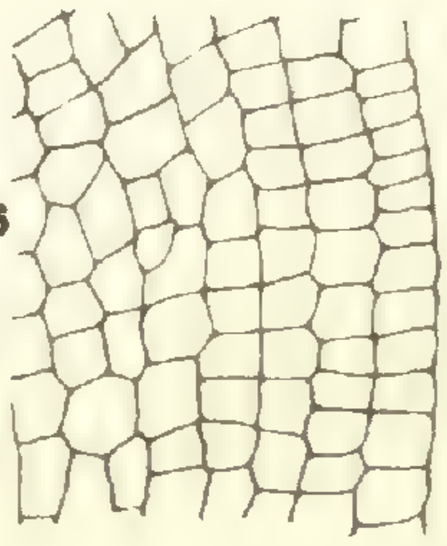
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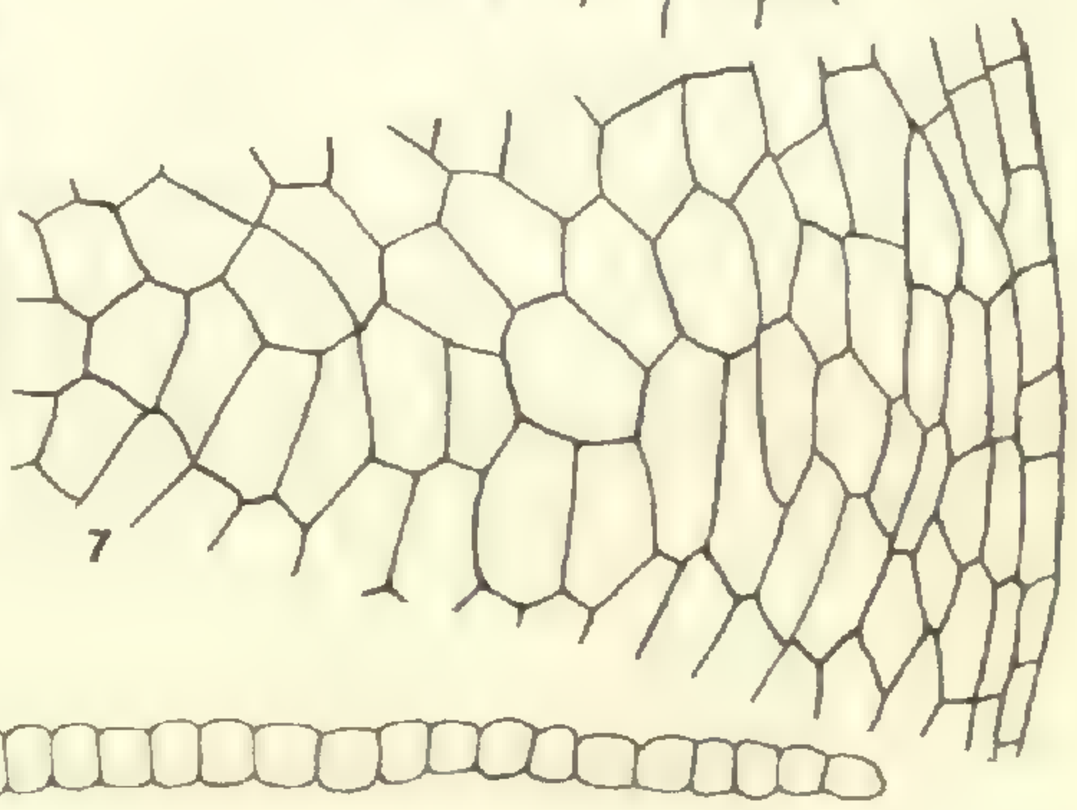
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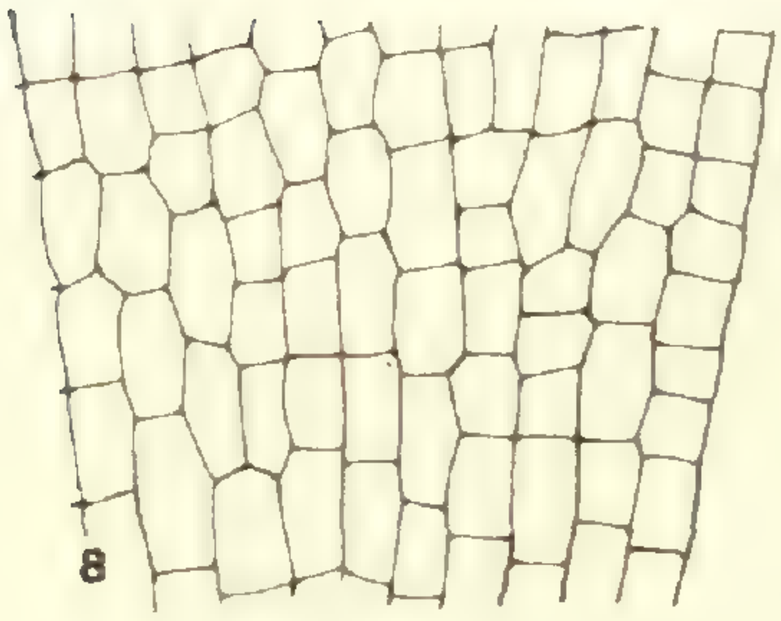
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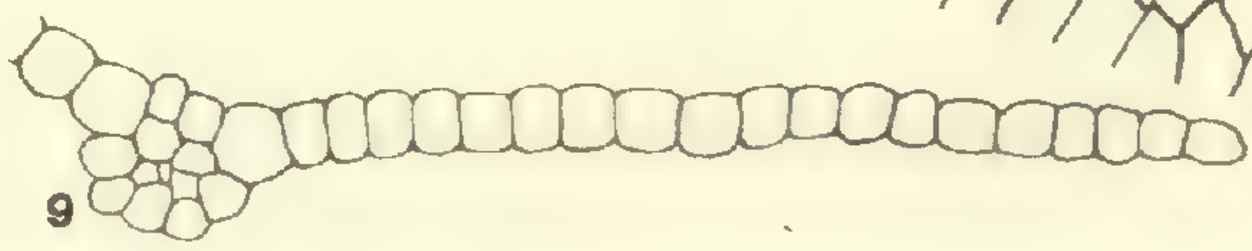
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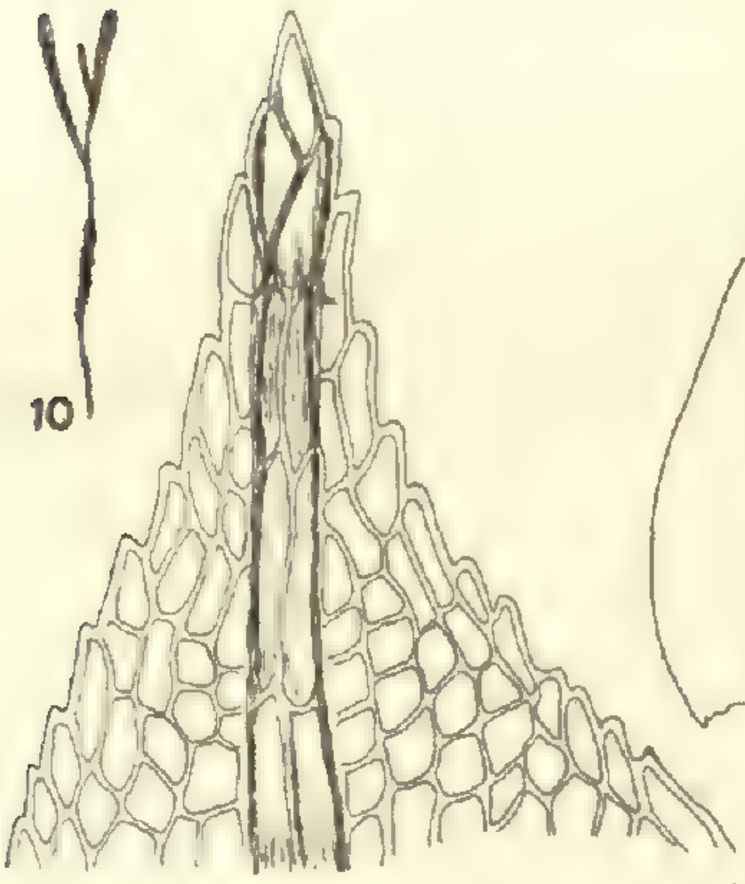
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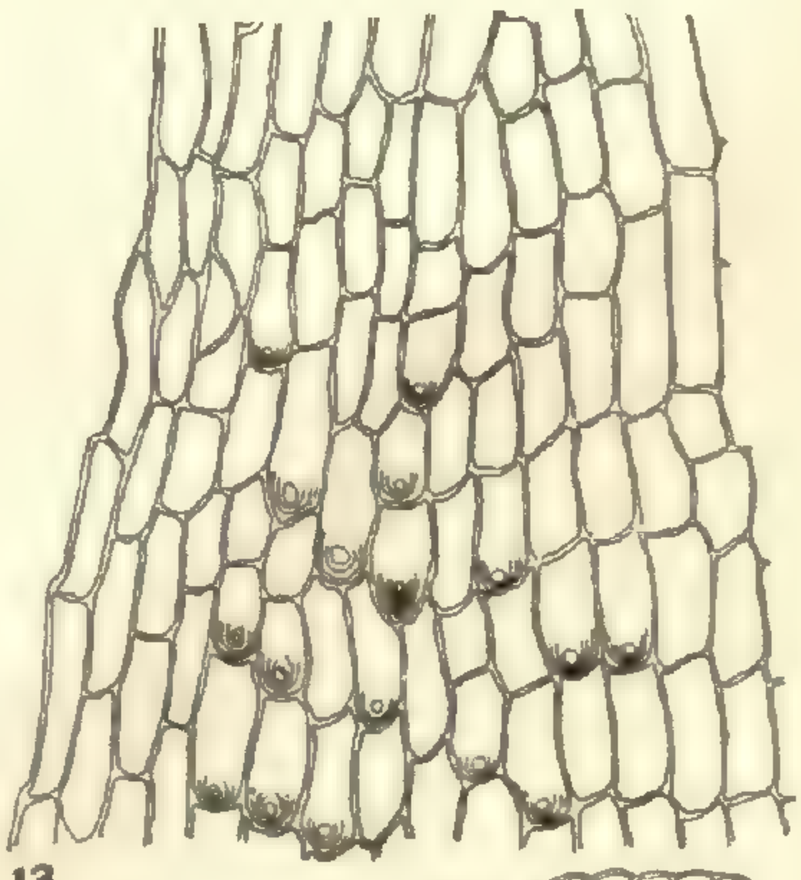
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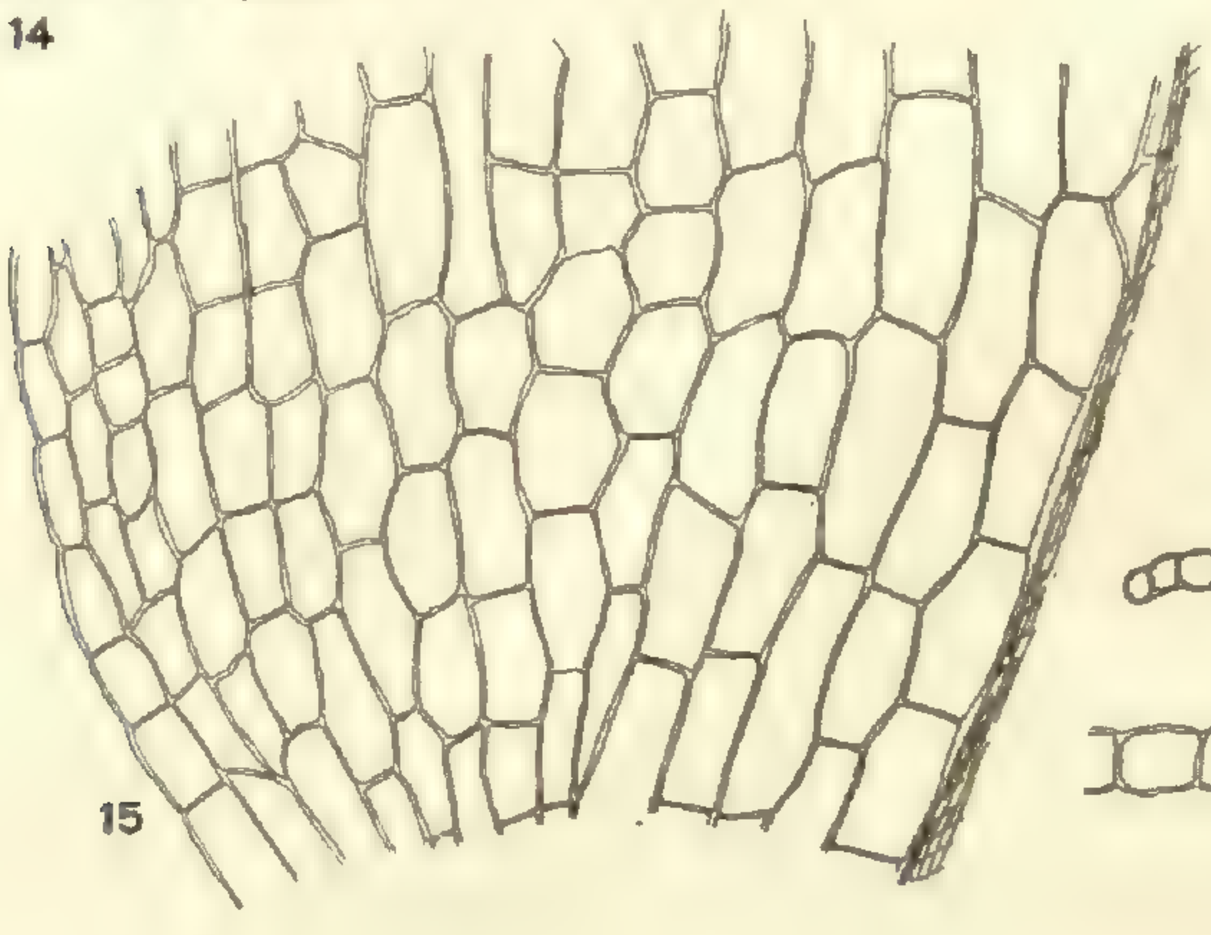
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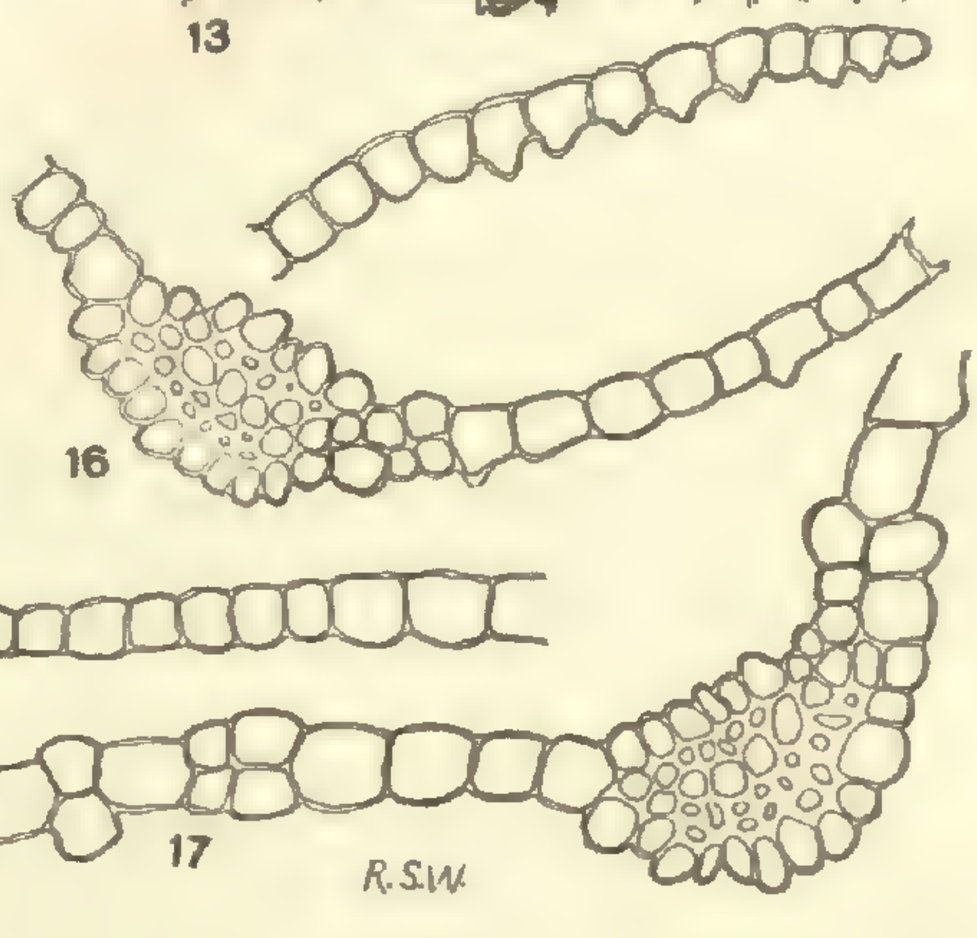
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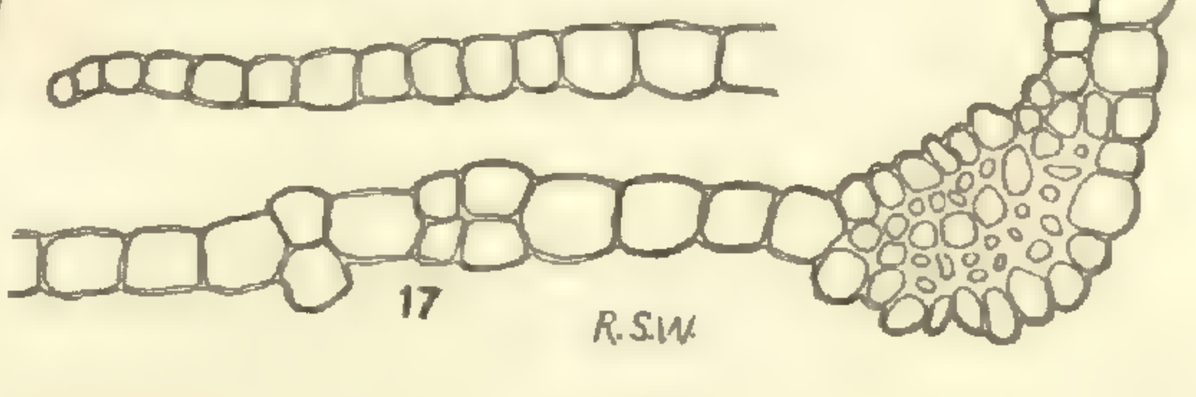
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1–9. PHYSCOMITRIUM ROSEAE R. S. WILLIAMS
10–17. PHILONOTIS FRAGILICAULIS R. S. WILLIAMS

Vol. 42 No. 8

BULLETIN

OF THE

TORREY BOTANICAL CLUB

AUGUST, 1915

The origin of dwarf plants as shown in a sport of Hibiscus oculiroseus

A. B. STOUT

(WITH PLATES 26 AND 27)

The publication in 1901–1903 of Die Mutationstheorie aroused a new interest in the well-known sports or spontaneous variations of earlier writers. While Darwin had recognized the occurrence of such variations he did not consider that they were the sole means or even the most frequent means by which species originated. De Vries sought to separate mutability as a type of sporadic variability from fluctuating variability, to define quite different laws for the two, and to ascribe to the former the only power to give rise to forms of specific rank.

Since 1901 much further evidence has accumulated regarding the appearance, the behavior, and the heredity of so-called mutations. It is fully established that marked variations do appear and that these are often hereditary. This phase of the general doctrine of variation is fully established. Of the various practical and theoretical considerations presented by these cases none are more fundamental than those relating to the expression and the heredity of "newly born" characteristics.

The general conception of mutation and the categories of behavior that indicate the process were combined by De Vries with the doctrine that plant characters are to be considered as so exactly represented by definite hereditary units that they can be properly called "unit characters." De Vries especially em-

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phasizes this view in the preface of the English translation of Die Mutationstheorie (1909).

It has also been shown that numerous cases of hybridization result in an increased variability in the F_2 generation over that of the parents, in the production of intermediate forms, and in unexpected ratios. The Mendelian factorial hypothesis, which attempts to explain such phenomena, assumes that the difficulties of analysis in terms of unit characters indicate that characters are themselves the results of the combined action or interaction of hereditary units called factors to which various values can be attributed as seems necessary. There are some striking cases of reversion resulting from crosses that seem to support this view; as, for example, the production in sweet peas of the reversionary purple bicolor known as "Purple Invincible" from crosses between certain white flowering strains of "Emily Henderson" (Bateson, 1913, Chap. V). The developments of the Mendelian theory have led, however, to various and conflicting conceptions regarding the nature of the hereditary units and of the fundamental processes of mutation or discontinuous variation.

De Vries on the one hand considers that mutability is due to lability of hereditary physiological units; these change from stable to labile, from active to inactive (or latent) or even to a semilatent condition, giving irregularities of expression both in inbred and crossbred lines of progeny. Only in the rare cases of progressive mutation are new characters added and in none of the mutations is complete loss of hereditary qualities essential. The units of De Vries assume different degrees of activity; they are not uniform and consistent units in their influence.

In marked contrast to this view is the conception of Bateson that all variation is due to the presence or absence of "unit factors", that all true mutation is due to loss of factors, and that cases of discontinuous variation resulting from crosses are reversions which are due to recombination of factors. This view minimizes the occurrence of latency, ignores lability and insists on a rather rigid unity of assumed hereditary units, not in any sense comparparable with the appearance of the visible characters of plants.

These two very different interpretations indicate clearly the

difficulties that arise in the attempts to analyze the facts of heredity and variation in terms of units and raise anew the questions as to the validity of the conceptions regarding mutation.

It is the purpose of this paper to present the facts as thus far determined regarding the origin and the behavior of a marked variation in *Hibiscus oculiroseus* and to point out some considerations suggested by such cases.

THE DWARF FORM OF HIBISCUS OCULIROSEUS

The two plants shown in PLATE 26 are typical for the appearance of dwarf and robust plants of *H. oculiroseus* at the end of the first year of growth as handled in my cultures. Both plants were from seed planted in January, 1914. The seedlings were grown in pots in a greenhouse until May, when they were planted in adjoining beds in the experimental garden. The photograph was taken September 13, 1914. A glance at the plate will show the marked differences that exist between the two types. The dwarf plant is shorter, but is more branched with large well-developed lateral branches arising close to the base; the internodes are shorter, making the leaves more crowded; the leaves are smaller and many of them are somewhat irregular or asymmetrical in outline and many of them are crinkled. Few of the dwarf plants have thus far come into flower, but those that have showed flowers nearly if not fully as large as the robust types.

From the data regarding the ancestry of the dwarf plants, it appears that a plant of *Hibiscus oculiroseus* was obtained by the New York Botanical Garden from the firm of Pitcher and Manda in the year 1896. This firm obtained their original stock of this plant from Mr. W. F. Bassett of Hammonton, New Jersey, who introduced the plant (Britton, 1903) into the trade some years before. Bassett obtained the first plant of this type about the year 1880 from a colony of wild plants growing near Absecen, New Jersey. The plant was propagated by seed, and introduced into the trade. It was commonly called the "Crimson Eye."

Britton (1903) points out that this type differs from *H. Moscheutos* in several characters. *H. Moscheutos* in its most abundant form, at least in the vicinity of New York City, has flowers of a

rose color, lighter along the veins and becoming nearly pure white for about 1 cm. at the base of the corolla lobes. *Hibiscus oculiroseus* has a rose red or Tyrian rose eye about 2 cm. in radius, beyond which the petal is a sea-foam yellow. The flower pods are ovoid with a long tapering point, the calyx segments are triangular-lanceolate and nearly twice as long as broad. *Hibiscus Moscheutos* has a nearly globular bluntly pointed pod. On this account he gives the type specific rank under the name *H. oculiroseus*.

CULTURES OF H. OCULIROSEUS AT THE NEW YORK BOTANICAL GARDEN

Open-fed seed was collected from the plant obtained from Pitcher and Manda and planted for the purpose of increasing the stock of the species. The progeny (Nash, 1909) was composed in part of plants conforming to *H. oculiroseus* and in part of plants whose flowers suggested that the plants were hybrids between *H. oculiroseus* and the rose-flowered type of *H. Moscheutos*, an assumption which the writer has since proved to be true by controlled crosses.

At the time the writer began his investigations with *Hibiscus* (1911) there were seven plants of the *H. oculiroseus* characters growing in the Garden, all derived from the one parent plant. All of these were vigorous plants about five feet tall. Five of these plants have been used as parents and will be referred to as *O* No. 1, *O* No. 2, etc.

One of these plants (*O* No. 1) produces each year a considerable number of leaves, somewhat crinkled and irregular, and the uppermost internodes of the branches are somewhat shortened. One would be inclined to attribute this to a fluctuating variation due perhaps to local soil conditions. The other four plants show no trace of any of the dwarf characteristics.

PLANTS OF THE FIRST PEDIGREED GENERATION

In 1912, fifteen plants (Series I) were grown from open-fed seed collected from the plant *O* No. 1. Fourteen of these were robust and vigorous in growth, but three of them had some leaves

irregular in shape and also exhibited a shortening of internodes at the tips of stems quite identical to that of the parent plant and were in general intermediates between the robust type and the extreme dwarf type. One plant was of the dwarf type quite identical with the one above described. Ten of the plants, including the dwarf and one of the intermediates, were grown in 1913, when all bloomed. The dwarf plant (No. 1 of Series I) continued small and much branched with many crumpled leaves. Two capsules of selfed seed were obtained from this plant and one capsule was obtained from a sister plant (No. 5 of Series I) of the robust type.

As to flower coloration and pod character, nine of the ten plants were typical *H. oculiroseus*. One plant had flowers with faint pink coloration outside the eye in the blade of the corolla, although at a short distance or upon casual survey the flowers appeared to be typical *H. oculiroseus*. There was outside of this one plant no indication but what the seed obtained was strictly selfed, and even in this one case the flowers borne were not such as have been obtained in the F_1 hybrids between the parent plant and the only other type of *Hibiscus* growing in the vicinity of the seed parent.

The winter of 1913–14 was unusually severe on the *Hibiscus* plants growing in the experimental plots, killing about 1,500 plants of various cultures, including the dwarf plant (No. 1) and the robust plant (No. 5) of Series I, from which selfed seed had been obtained.

In addition to the plants of Series I, there were also grown during the summer of 1913 forty-five plants (Series VI) derived from selfed seed obtained during the summer of 1912 from the same parent plant (*O* No. 1). All of these were dwarf plants. Four produced flowers that were typical *H. oculiroseus*. No seed ripened and all the plants died during the winter of 1913–14. All the plants of this series were dwarfs, while of the fifteen plants of another series (Series I) from a pod of the same parent only one dwarf appeared as already noted.

The dwarf character of these plants was most conspicuous in comparison with the selfed progenies of four other plants of *Hibiscus oculiroseus* (sister plants of *O* No. 1) grown during the

summer of 1913 from seed of 1912. The data for these can be briefly summarized as follows: from plant *O* No. 2, nine plants were grown, of which four bloomed; from plant *O* No. 3, forty plants, of which ten bloomed; and from *O* No. 5, twenty-seven plants, of which none came into flower. All of the plants in these four series, 103 in number, were typical for the robust type with no trace of any of the dwarf characteristics. The twenty-four plants that bloomed were true to the *H. oculiroseus* type of flower. None of the plants matured seed and every one was killed during the winter of 1913-14.

PLANTS OF THE SECOND GENERATION

In the summer of 1914 three series of plants were grown, constituting a second generation in descent from the parent *O* No. 1. These may now be described.

Series VII. The parent of this series was a dwarf plant (No. 1 of Series I). Thirty-five plants were grown from seed of a single pod. Twenty-seven were uniformly of the dwarf type; one was a typical robust plant and seven were intermediates showing in slight degree the characteristics of the dwarf type. Six plants bloomed; one had eyed flowers with pale pink in the blade (quite similar to No. 8 of Series I), three had the eye somewhat diluted, and on two the eye of the flower was so diluted that the flowers appeared to be nearly pure white. The one plant of robust habit had flowers of a type which suggests that it is a stray plant of hybrid origin.

Series VIII. Of the same parentage as the Series VII. Forty-six plants were grown from selfed seed of a single capsule. Forty-five of these were dwarf quite like the one from this series shown on PLATE 26. One plant was intermediate but was different from other intermediates in possessing a considerable development of lateral branches, the main branch was itself robust and the leaves were only slightly crinkled. The five plants that bloomed were all typical for the *H. oculiroseus* type and were only slightly if any smaller than the flowers of robust plants. The plants of this series are shown in the middle of PLATE 27 with the marker standing in their midst. The plants of Series VII are shown

beyond the label stake in the rear. The intermediate plant in Series VIII just mentioned is shown at point *a*. To the right in the foreground are hybrids between *O* No. 2 and a plant of *Hibiscus Moscheutos*, and to the left are hybrids between two types of *H. Moscheutos*, all of the same age as the dwarf plants.

Series IX. The thirty-four plants of this series were grown from the selfed seed of one capsule of plant No. 5 of Series I. The parent was a robust plant. Thirty-three of the plants were of the robust type quite uniformly like the one of this series shown on PLATE 26. One plant was classed as an intermediate; it was smaller than the others, its leaves were somewhat crinkled, but it was not branched from the base. Twelve plants produced flowers; ten of these were typical *H. oculiroseus*, one had flowers with slight pink coloration outside the eye, and on one plant the flowers were quite pink outside the eye, quite like the flowers produced by hybrids between *H. oculiroseus* and the pink-flower type of *H. Moscheutos*.

Nearly all the plants of these three Series (VII, VIII and IX) lived through the winter of 1914–15 and were grown during the summer of 1915 in the same beds as in the previous year. In the second year of growth several main stems, usually three to five, are produced by the single cluster of roots belonging to a plant. As the plants were grown about 30 cm. apart they were much crowded in the second year, which is a condition that does not favor the development of secondary branches and hence the plants were much less bushy than in the first year of growth. Under these conditions there were fewer differences between plants previously classed as intermediate and dwarf.

In 1915 the plants of Series VII ranged from 1.25 m. to 1.6 m. in height with the exception of the plant classed as robust which was 2.08 m. tall but which from the character of its flowers appears to be an accidental hybrid. Series VIII ranged from 1.3 m. to 1.6 m. in height. The dwarf plant shown to the left in PLATE 26 had four main branches and stood 1.45 m. tall and was typical for the average plant; the plant shown at point *a* in PLATE 27, classed as intermediate in 1914, was of nearly the same height and appearance. Series IX, described as robust in 1914, varied

from 1.75 m. to 2 m. in height with the average quite 0.3 m. taller than that of Series VII and VIII.

During 1915 there was also grown from seed a series of twenty-eight plants from selfed seed of plant *O* No. 1, the parent of the Series I and VI. On August 25, these plants varied from 0.4 m. to 0.75 m. tall and nearly all had the dwarf characteristics. The series showed greater variation in general vigor than did the plants of Series VII and VIII in their first year of growth. A series of twenty-three plants derived from selfed seed of one of the robust plants of Series I, grown at the same time were in comparison decidedly robust averaging from 0.8 m. to 1 m. in height and with no crumpled leaves or strongly developed lateral branches. Another series of eleven plants descended from a plant of Series I classed as intermediate was on the whole intermediate between the two series just mentioned.

SUMMARY OF THE CULTURES

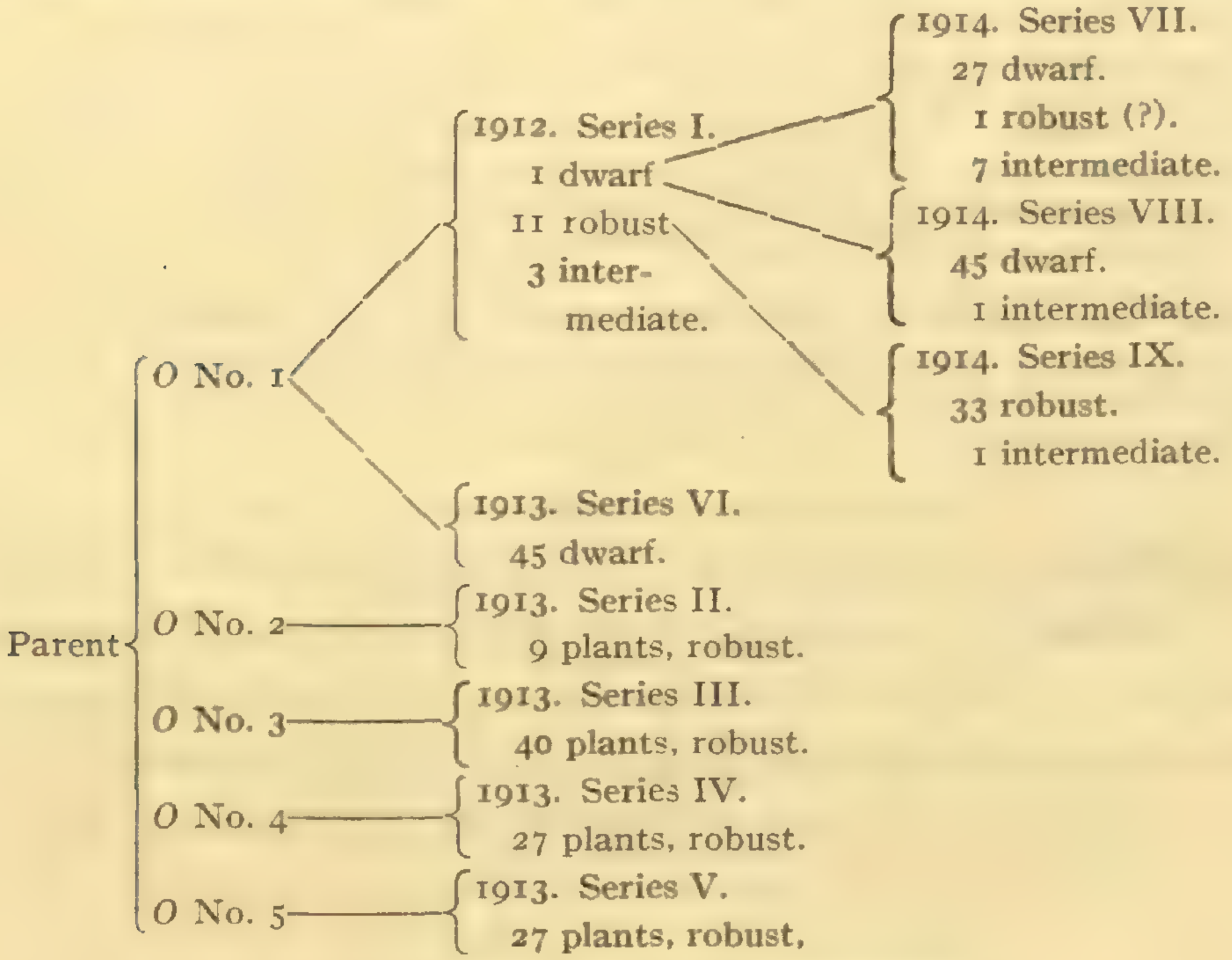
A total of 288 plants have been grown (at least through a single season) from seed obtained from five sister plants of *Hibiscus oculiroseus*. The dwarf type of plant has appeared only among the progeny of a single plant (*O* No. 1); the 103 plants derived from the other four sister plants were without exception of the robust type.

There was much diversity among the progeny of the plant *O* No. 1, and the two series of plants grown in the first generation gave quite different proportions. In Series I, there were eleven robust, three intermediate and one dwarf; in Series VI there were forty-five plants, all of which were dwarf.

The progeny of a single dwarf plant (the only one that has thus far matured seed) was composed of one robust (later appearing to be an accidental hybrid), eight intermediate and seventy-two dwarf plants. While the dwarf type has not bred true the greater number of the progeny are of that type. There is a pronounced tendency to breed true. Robust plants in this line of descent do not always breed true, as the only one tested gave one intermediate plant and thirty-three robust plants.

A condensed schematic presentation of these facts regarding

the progenies of different lines of descent, not including the series started from seed in 1915, is given in the accompanying diagram.



DISCUSSION

The dwarf type of *Hibiscus oculiroseus* constitutes a marked and distinct variation from the usual robust type of the species. It has smaller leaves, many of the leaves are crumpled, the internodes are shorter, and there is an increased development of branches. It is such group-differences as these that constitute the elementary species of De Vries, for, as he states (1901, p. 176): "Elementare Arten unterscheiden sich von ihren nächsten Verwandten mehr oder weniger in allen ihren Merkmalen." All the changes, however, are considered to be a result of a change in the condition of a single pangen.

It is difficult or impossible to describe such a mutation in terms of definite characters that have been gained or lost. The ordinary type of development of the leaves and internodes have been modified mainly in the direction of arrested growth, while the amount of branching has been increased, due chiefly to the development of basal lateral buds that usually remain dormant.

In comparison with the robust type the characteristics of the typical dwarfs are readily recognized, the general effect being

quite adequately shown in the illustrations on PLATES 26 and 27. The characteristics of the two types can be listed as follows:

Robust form	*Dwarf form*
First year of growth, 0.8–1.1 m.	0.4–0.75 m.
Second year of growth, 1.75–2 m.	1.25–1.6 m.
No branching from base of shoots.	Large branches from base.
Internodes about 30 in number.	Internodes about 30 in number, but all proportionally shorter.
Leaves ovate, larger ones lobed, palmately veined, densely white stellate-pubescent beneath, glabrous above; leaves all flat.	Leaves identical except that the largest are smaller than the average of robust type; many leaves crinkled.
Flowers and fruit are typical *H. oculiroseus*.	Flowers and fruit identical with those of robust form; apparently no smaller.

While typical plants classed as robust and dwarf were very uniform in the above characteristics, there were a few plants, as noted, described as intermediates or semi-dwarfs, which possessed in some degree of development one or more of the characters of the dwarf form but which in the second year of growth were less distinguishable.

The mutant of *Oenothera Lamarckiana* that most nearly approaches in its characters the dwarf *Hibiscus* is, of course, *Oe. nanella*. The principal characteristics of this plant compared with those of the parent form as given by the description of De Vries may be given as follows:

Oe. Lamarckiana	*Oe. nanella*
Robust: 1.5–1.8 m. tall.	Dwarf: about one-fourth as tall as *O. Lamarckiana*, often blooming when 10–20 cm. tall.
Secondary branches abundant and strong.	Secondary branches lacking or nearly absent.
	Internodes much shorter making leaves and flowers more compact.
Leaves ovate-lanceolate; long petioled, much crumpled surfaces.	Leaves sessile or nearly so; broad at base, often auriculate or heart-shaped; petioles very brittle.
Flowers with petals 3–4 cm. long; buds thin, tapering to a point.	Flowers very nearly as large; buds often laterally twisted.
Fruit and seeds normal.	Fruit and seeds of almost normal size.

The dwarf *Oe. nanella* differs from *Oe. Lamarckiana* in nearly all of its vegetative organs. De Vries maintains, however, that such a mutation is brought about by a change in the activity of

a single hereditary "pangen," but that the visible result depends only partly on the direct results of the changed condition in one pangen. On this point he states (1901, p. 305): "Der äussere, sichtbare Erfolg hängt also nur zum Theil von der Mutation, zum Theil aber auch von den älteren Merkmalen ab. Oder mit anderen Worten, die neue Art kennzeichnet sich in der Regel nicht durch eine enizige neue Eigenschaft, sondern dadurch, dass veile oder alle Organe in bestimmter Weise umgestaltet wurden." This means that in the case of *Oe. nanella* when the *alta* pangen (1913) becomes inactive it affects not only the height of the plant but also produces a transformation of many other characters, such as the nature of the leaves and the branching. De Vries states regarding *Oe. nanella* (1904, p. 532): "The most remarkable feature is the shape of the leaves. They are broader and shorter, and especially at the base they are broadened in such a way as to become apparently sessile. The stalk is very brittle, and any rough treatment may cause the leaves to break off." These remarkable differences in the leaves are brought about, De Vries assumes, by a change in the "*alta* pangen", a pangen concerned with the height of the plant. Such a view is, it would appear, *directly opposed to a conception of independence between heredity units.* We get in such cases the clearest possible conception of the application of De Vries's idea of a heredity unit ("pangen") as an element of the germ-plasm which affects and determines the character of a plant as a whole, constitutionally, and in all or many of its characters. Such a view is quite different from the units of Weismann, which were assumed to be individual in effect and sufficiently numerous to correspond directly to every detailed feature of expression.

The original Mendelian doctrines of unit characters assumed qualitative germ cell units, independent in action, and each responsible for the expression of a character. Color and wrinkledness of peas (qualities of the cotyledons) were considered as separable hereditary units quite independent of any preformation of the cotyledons themselves. Mendelian theories have been concerned with the phase of development and heredity which involves qualities, and though evading the difficulties of assumed spacial relationship in preformation, they assume that the qualitative

values of the "factors" are predetermined. It is an important fact established especially by Mendelian studies that qualities of organs may appear and disappear independently of the organ and to certain degrees independently of each other. This suggests that the older conceptions of the preformation of organs as such do not hold and that a hereditary unit for an organ with all its characteristics does not exist. This is very clearly seen in the numerous studies of inheritance and variation of color in which organs like petals, leaves, and stems of plants, eyes of insects, etc., re nain quite the same except for color. Such facts emphasize on the one hand the wide possibilities of latency as most excellently developed by De Vries, and on the other the most evident fact that qualities which appear to be localized in organs are more often general qualities of the entire organism, the development of which is a matter of intercellular and inter-tissue relationships.

The arguments of De Vries consistently seek to establish the doctrine of the fewness of the pangens. On this basis dwarfness is assumed to be the same in all the different cases in which it appears throughout the plant kingdom.

No consistent uniformity, however, exists among the dwarf types derived in different species or even in the same species. Some types of dwarf garden peas appear to differ from tall varieties chiefly in the character of the internodes. In the "brachytic" varieties of cotton (Cook, 1915) the shortened internodes a id modified leaves and bracts are usuall confined to the fruiting branches. Numerous types of dwarf and semi-dwarf types exist in many species, a notable instance of which has been recently described by Bartlett (1915), who found that two dwarf types arose in a single pedigreed generation of *Oenothera Reynoldsii*. One of these, *semialta*, is about half as tall as f. *typica* and has a very dense and showy inflorescence, in which the fruits and flowers are very little smaller than in the parent form. The leaves, however, are decidedly reduced. As described by Bartlett (1915, p. 130) the sister dwarf "*debilis* is more variable in size than mut. *semialta*, but averages about half as high as the latter. Its fruits and flowers are somewhat reduced, but by no means proportionally to the plant. The leaves, on the contrary, are much more reduced than those of mut. *semialta*".

Bartlett has not discussed these in terms of characters that have been gained, lost, or modified, but does point out that the appearance of these two dwarf forms as sister mutants in the rather large number of individuals "bears a certain degree of resemblance to Mendelian segregation." The case is especially interesting in affording a record of the simultaneous origin of hereditary variations from a single parentage giving dwarf forms of markedly different characteristics.

Furthermore, the facts of variation resulting from hybridization involving dwarf forms indicate a diversity of behavior quite in line with the above-mentioned facts. Mendel considered that the dwarf garden pea differed from the tall in a single character pair and that he obtained neither intermediates nor a greater range of variation in the F_2 generation. Darbishire (1911) considers that this is the case and that the dwarf garden pea differs from the tall variety only in respect to two types of internodes, long and short. Punnett (1911, p. 35) applying the conception of presence and absence very generally to peas states "all peas are dwarf, the tall pea is a dwarf plus a unit factor." This generalization is not borne out by the data. Lock (1904) in progeny of crosses between a tall and a semi-dwarf ("Satisfaction" and native No. 2) found in the F_2 great variation in habit ranging from very robust to very feeble dwarf. Although he considers that there must be some sort of Mendelian segregation if the internodes are solely considered, he admits that "this cross seems to afford an example of remarkable intensification of both the allelomorphic characters of the same pair, namely tallness and dwarfness, the former in the F_1 and both in the F_2 and later generations" (p. 414). Keeble and Pellew (1910) in crossing two well-known staple semi-dwarfs varieties of the garden pea obtained in the F_2 a wide variation, giving both dwarf and tall as well as intermediates. They conclude that length of internode and width of stem are both involved and in their interpretation dwarfs lack both factors, semi-dwarfs lack one and talls possess both. Height in sweet peas is also of complex character, as breeding studies of dwarf, semi-dwarf and tall varieties have shown. Crosses with bush and "Cupid" give an F_1 that is tall and an F_2 with variation involving plants that include tall, bush and

two types of "Cupid". Bateson attempts to explain this case as he does all cases of increased variation in terms of presence or absence of factors, giving *different interactions in different combinations.* The point is clear that greater variability does develop and that not only is height of sweet peas evidently a compound character, but that the assumed factors take on different values. For example, the factor T ("tallness") when combined with P (erect: branching) gives the bush variety. The two sets of allelomorphs assumed in this case are not independent units in expression. It may be emphasized that the original rigid unit-factor hypothesis is being given up in favor of the admission, as we see in this case, of a marked modifiability of the effect of the assumed factors. The integrity of the assumed units in these cases can only be maintained by assuming a permanence in them, which is entirely at variance with the visible results which they are assumed to produce.

The behavior of the dwarf characteristics of *Oenothera nanella* in hybridization is of special interest in this connection. The group of characters appearing in *Oe. nanella* go together in crosses with *Oe. Lamarckiana*, not as a unit giving alternative expression but in the splitting that develops in the F_1 generation giving the parent forms as twin hybrids. De Vries assumes (1913) that the *alta* pangen is inactive in *Oe. nanella* and labile in *Oe. Lamarckiana.* In this case inactive $\times$ labile gives both inactive and labile.

When *Oe. rubrinervis* is crossed with *Oe. nanella* splitting also occurs in the F_1 giving *Oe. Lamarckiana* and a new type called *Oe. subrobusta.* The *alta* pangen in *Oe. rubrinervis* is assumed to be active, so in this case active $\times$ inactive = labile and inactive + active. The *Oe. subrobusta* form splits in the next generation, giving dwarf forms which, however, are evidently not *Oe. nanella. None of the types derived are like either of the two parent forms.*

Again when *Oe. muricata* is crossed with *Oe. nanella* the F_1 is of two new types called *Oe. laeta* and *Oe. velutina.* *Oe. velutina* splits up in the F_2 giving a dwarf *Oe. murinella* that is not like *Oe. nanella.* None of the types are like the parent forms. The assumed condition of the *Oe. alta* pangen in this case is active $\times$ inactive = labile, active and inactive.

The appearance of twin hybrids not like the parents and of sec-

ond generation dwarfs not like *Oe. nanella* is also the rule in crosses between *Oe. nanella* and *Oe. Hookeri*, *Oe. Cockerelli*, *Oe. cruciata* and also *Oe. biennis* when the latter is the seed parent.

When *Oe. nanella* is fertilized by pollen from *Oe. biennis* the F_1 is composed largely of dwarf plants. In the earlier crosses De Vries reports a few tall plants and many dwarfs (1913, p. 241) but from a cross in 1907 he obtained only dwarfs which, however, he classed in two types, *Oe. semialta* and *Oe. debilis*, each of which was different from the *Oe. nanella* parent. In this case the condition of the *alta* pangen in the hybrids is assumed to be inactive × labile, which is the same condition assumed for *Oe. nanella* × *Oe. Lamarckiana*.

De Vries finds in such behavior evidence of the production of new species in groups by hybridization. He assumes that a few pangens are involved and that those exist in few conditions. The integrity of such units can only be assumed by calling in such all-sufficient properties as lability and inactivity which admit of very sporadic behavior.

It is generally assumed that a new elementary species arises suddenly without transitional forms. This is not the case with the dwarf type of *Hibiscus* here described. The plant *O* No. 1 from which all dwarf plants thus far obtained have arisen, possessed a few of the characteristics of the dwarf. The next generation gave dwarf, intermediates and robust plants in quite irregular numbers in the two series grown. Bartlett (1915) describes two dwarf types arising in a progeny of *Oe. Reynoldsii*, one of which (*semialta*) is intermediate in general stature and has leaves less reduced than in the extreme dwarf form (*debilis*). Variations such as these are not like ordinary fluctuations in giving a frequency distribution agreeing with Quetelet's law and they do not conform to the Mendelian ratios of segregation, although as Bartlett points out, there is much in the behavior that suggests the segregation assumed by Mendelian interpretation. *They are irregular and sporadic variations* involving different degrees and intensity of change. The most marked of these involve changes affecting the character of several organs.

Further evidence regarding irregular expression of characters is

seen in the well-known cases cited by De Vries of non-isolable races, eversporting varieties, and inconstant species, indicative of irregular and sporadic inheritance and expression of ever present tendencies which in these cases rigid selection fails to isolate.

That there are cases of variation that are cumulative is evident. De Vries especially has given data on two such cases. In a race of *Chrysanthemum segetum*, having an average of twenty-one ray florets in the terminal inflorescence in a crop of 1,500 plants one plant was found with four lateral flower heads with twenty-two ray florets. Seed from this plant gave a progeny of 423 plants one of which had a terminal inflorescence of thirty-four rays. Seed from this plant gave a mixed progeny with one plant having sixty-six ligulate florets, three of which were among the tubular disk flowers. Seed from this plant gave progeny with florets ranging from thirty-three to one hundred and one with a few completely double flowers.

In respect to these results De Vries says (1901, p. 526): "Es wird sich jedem Leser die Frage aufdrängen: ist dieser Uebergang ein allmählicher oder ein stossweiser gewesen? Mir scheint das letztere der Fall zu sein, aber es hängt dabei viel ab von der Bedeutung, welche man den Wörtern giebt. Jedenfalls geschah die Umwandlung nicht im Laufe der Jahrhunderte, wie es die Selectionstheorie anzunehmen pflegt, nicht einmal brauchte es dazu Jahrzehnte. Drei Jahre genügten, und solches in einer Cultur von nur wenigen Quadratmetern Umfang."

De Vries considers that this result is due to the reappearance of a latent character. It is not clear what the latent character is in this case. The species already possessed ray flowers in the outer circle of flowers. The development of a so-called double-flowered race consisted of a change of tubular flowers to ray flowers. Furthermore, as wholly double flowered plants are sterile, the double flowered plants are obtained continually by planting seed from plants not fully double flowered.

A similar case is seen in the development of *Linaria vulgaris peloria*. Individuals of certain races produce rarely a single peloric flower, an evidence De Vries considers of a semi-latent character which seldom becomes active. Seed from two such plants gave

out of a generation of two thousand one hundred plants, twenty plants having only peloric flowers. Progeny of these peloric plants gave ninety per cent. true to the type. In both *Chrysanthemum segetum* and *Linaria vulgaris peloria* self sterility made it difficult to grow pure line progenies. De Vries points out (1901, p. 564) that while he considers these as cases of mutation they are of a type quite different from that in *Oenothera*. In regard to the origin of such variations that are hereditary the evidence is not at all conclusive that slight variations may not be inherited even in a cumulative manner.

That this is the case is further suggested by the difficulty of drawing a definite line of distinction between species, varieties and races. De Vries, who has written most fully on this point from the standpoint of genetics, states that the best examples of varieties are those showing latency of a single character which may be just as constant as species (1901, p. 119); again he treats *O. nanella* (1901, p. 256) as a variety simply because somewhat similar dwarf types recur in a great number of species. He also gives the general view that varieties usually differ in one character (1901, p. 363); he states in another connection that the chief difference between improved races and species, even the smallest of elementary species, is the instability of the former and the stability of the latter (1901, p. 84); but we may note that inconstant species do occur (1901, p. 270).

It is clear that some cases of sporadic variation reproduce more true to type than others. The so-called law of mutation that "neue elementare Arten sind meist völlig constant, vom ersten Augenblicke ihrer Entstehung an" (1900, p. 175) is itself a qualified statement. The difficulty of assigning a definite heredity in terms of unit characters or unit factors to "newly born" characteristics which appear in mutations has become apparent. This is especially recognized in part by the view of Gates that mutation is a phenomenon of variability which is quite distinct from heredity.

Thus far progeny has been grown from only one of the dwarf plants of *Hibiscus oculiroseus*. One capsule of seed gave forty-six plants, all but one of which were dwarf, and another capsule gave twenty-seven dwarf, one robust and seven intermediates as judged

by the growth made the first year. The type appears to be only slightly inconstant. Further breeding tests will determine if the type becomes more constant by selection and if differences exist between the progenies of different dwarf plants.

There has been much discussion recently regarding the possibility of the association of hybridization with mutation especially in the Oenotheras. The rather well-known history of *Hibiscus oculiroseus* and its dwarf mutant is of significance in this respect. The wild form of *H. oculiroseus* was originally found in a region in which the species *H. Moscheutos* exhibits much polymorphism, involving problems which the writer now has under investigation. Its affiliations with this species are so evident that for some time it was known as a variety. The several differentiating characters possessed by *H. oculiroseus* have already been noted and while a few variations have been observed in my pedigreed cultures the species breeds remarkably true to type. In fact the only variations that have appeared have been among the progeny of the plant giving dwarf plants, and none of the variations suggest that this particular plant is a hybrid at least of the usual type. As far as now known, *H. oculiroseus* has a limited distribution in nature and since it is closely associated with *H. Moscheutos* it may well be that it has been derived from this species.

Mr. George William Bassett, owner of the William F. Bassett nurseries, writes in 1915: "We have never, to my recollection, observed any dwarf tendency in *Hibiscus* 'Crimson Eye.' Nor have we had any occasion to throw any out for any cause." It does not appear that dwarf forms have appeared in the cultivation of the species. Mr. Norman Taylor reports to the writer that he has observed in Long Island colonies of dwarf plants of the pink-flowered form of *H. Moscheutos*.

The evidence indicates that the dwarf form is of spontaneous origin. There is no series of characteristics belonging to either *H. Moscheutos* or the parent stock of *H. oculiroseus* that can be considered as combining to produce the dwarf, an interpretation given to the origin of *Oe. gigas* by Heribert-Nilsson (1912). The immediate parent (*O* No. 1) of the dwarf plants possessed in slight degree the characteristics of crinkled leaves and shortened inter-

nodes which later appeared more intensified in the dwarf plants. This, coupled with the variability of the progeny, might be considered by Mendelians to indicate that the parent plant was a half-mutant. While it is no doubt true that such cases do occur (a most notable case is that of *Oe. semigigas*), it is evident that the conception has been applied to many cases of irregular inheritance and sporadic variation and even to instances of cumulative variation.

A most important type of discontinuous variation is that of simultaneous variation in a group of characters, well illustrated by the dwarf *Hibiscus*. Not only is a number of characters modified but the habit of profuse branching from the base appears as a character quite new to the parent species. Such phenomena are not well explained on any conception of continuous unit characters.

Bateson does not admit that such simultaneous variation can occur as a sporadic variation. He does not believe in the mutation and inheritance of group-characters as described by De Vries and already mentioned with respect to characters of *Oe. nanella*. He prefers to think of the phenomena as due to a recombination of factors. His strongest evidence for this view is the apparent marked reversions that appear in certain crosses. If, however, recombinations can give new groups or develop characteristics new to the particular race and species, his analysis is of doubtful validity.

To assume that a variation such as the dwarf *Hibiscus* is due to a single change in a single hereditary unit is to assign to the units different values and to admit of interaction between units. On the other hand to assume that there are hereditary factors that are themselves stable but that can interact upon each other in various ways is to assign different values to the supplementary or coördinating units and to the various interactions between them. This makes the comprehensive description of the processes of heredity in terms of units other than characters of doubtful validity.

It is quite clear that hereditary variations giving dwarf forms of various degrees of intensity and extensity do arise. If in all cases single characters, factors or other hereditary units are con-

cerned the evidence is clear that they possess different potencies and belong to quite different categories, or else that they undergo quite different sorts of changes not only in different species but in the same species, variety, strain or even pure line.

The accumulation of evidence from all lines of plant breeding shows that sporadic and irregular expression and inheritance of characters are frequent and are widely distributed among plants, and that ordinary stable characters and combinations become split up and modified in processes of both mutation and hybridization, giving variability not conforming to the usual laws of fluctuating variability.

SUMMARY

A dwarf form of *Hibiscus oculiroseus* has appeared in a pedigreed culture as a sporadic variation. It differs from the robust form in possessing a smaller stature, shorter internodes, smaller leaves, many crinkled leaves and in the development of lateral branches from the base of the main stem.

Plants intermediate between the dwarf and the robust forms appear. These possess one or more of the characters of the dwarf type in some degree of development.

All the dwarf plants thus far obtained are the progeny of a single plant (*O* No. 1). No dwarf plants appeared among the 103 plants grown as progeny of four sister plants of plant No. 1.

The parent plant of this dwarf (*O* No. 1) possessed already in slight degree the characteristics of crinkled leaves and shortened internodes.

The dwarf plants appeared in varying numbers along with robust and intermediate types. One series (Series No. I) was composed of one dwarf, eleven robust and three intermediate plants; another series (Series VI) was composed of forty-five dwarf plants.

There is a strong tendency for the dwarf form to breed true. In a total of eighty-one plants grown from seed of a dwarf there were seventy-two dwarf plants, eight classed as intermediates, and one that was robust (Series VII and VIII).

It is difficult to describe the dwarf type in terms of characters that have been lost or gained. The smaller and crinkled leaves and the shortened internodes are evidences of reduced or arrested

growth. In the marked development of branches from the base there is increased growth or at least development of buds that usually remain dormant.

There is no series of characters of either *H. oculiroseus* or *H. Moscheutos* that can be considered as combining in hybridization to give the dwarf.

The simultaneous appearance of variations involving modifications of groups of characters and of intermediates of various kinds exhibit sporadic variations of various degrees of intensity quite in line with the general evidence of the sporadic nature and wide range of such variations.

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Explanation of plates 26-27

PLATE 26.

To the left, typical plant of the dwarf form of *Hibiscus oculiroseus* (Plant No. 14 of Series VIII). To right typical plant of the robust form (Plant No. 23 of Series IX). Photograph taken September 13, 1914. Both plants are seven months old.

PLATE 27.

View in garden. In center with marker in the midst is a series (Series VIII) of dwarf plants. Plant indicated at *a* is an intermediate. At the right is a series of hybrids between *H. oculiroseus* (Plant *O* No. 2) and the pink-flowered type of *H. Moscheutos*. To the left is part of a series of hybrids between white-flowered and pink-flowered forms of *H. Moscheutos*. The three series are of the same age and illustrate the difference between the dwarf and the robust forms.

A study of pasture trees and shrubbery

ERNEST L. SCOTT

(WITH THIRTEEN TEXT FIGURES)

Some years ago my attention was called to the peculiarly regular form of the thorn trees in the pastures of northeastern Ohio. These peculiar shapes are taken by the trees in response to the constant pruning to which they are subjected by the cattle. A very short study revealed the fact that other species are as characteristically affected as the thorns; this is especially true of wild apples, oaks and elms. Further, the behavior of each of the different types has features peculiar to itself. Many kinds of trees are not able to withstand the constant browsing to which they are subjected when growing in closely cropped pastures and so quickly disappear. On the other hand several species are not molested at all by the cattle. The "immunity" which is enjoyed by most nut-bearing trees seems to depend upon a taste or texture which is repugnant to the cattle. Whether or not this explanation is of wider application I do not know.

FIG. 1. A sugar maple found growing in an open pasture. The annual rings indicated an age of about 25 years. The maximum height was 45 cm. This tree appeared to be vigorous in every way and well able to maintain itself in this miniature form in spite of the cattle.

There is of course considerable variation in the relative abundance of the different species in the different pastures. But considering

the region as a whole the haws are the most conspicuous, not only because their striking contours but because of their number and size as well. Wild apples are frequently associated with the haws and resemble them so closely in form that the two species might easily be confused on superficial observation. Elms are very common in some pastures, but owing to the small size which they are able to attain they are inconspicuous, and would

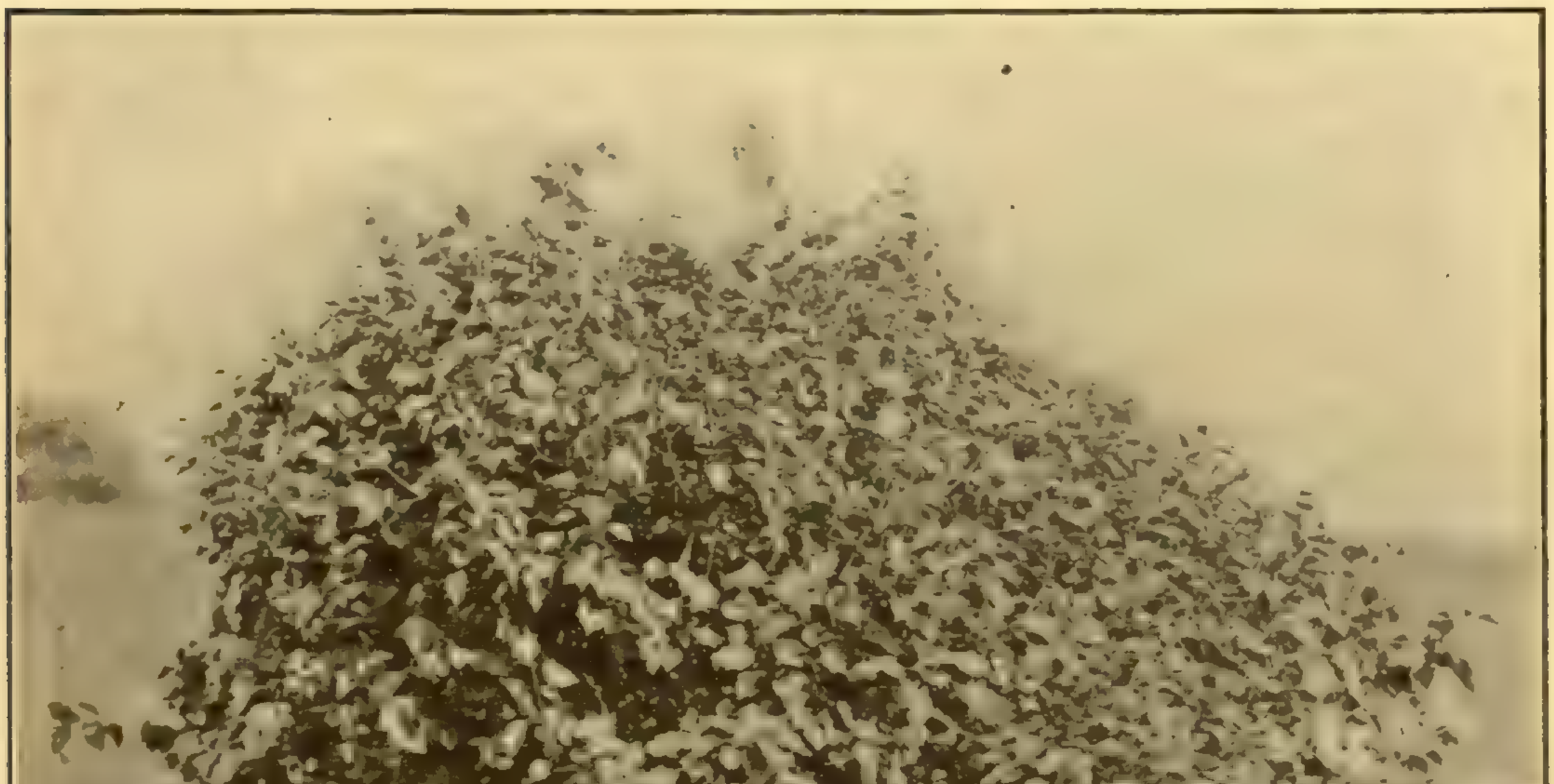

FIG. 2. A haw in the second or spheroidal stage. This particular individual was 1.5 m. high and 2 m. in the greatest diameter. Though its age was not ascertained, other trees in the corresponding stage showed annual rings indicating an age of 10 to 20 years.

often escape the notice of the casual observer. The oaks seem to have partially solved the problems set for them by the cattle and by reason of their number and size demand attention. The hickories are, in general, avoided by the cattle and so are usually able to reach maturity when once started—at least so far as the cattle are

concerned. However, when they are attacked they usually succumb when the browsing is severe, but if the punishment is not too great they respond in a manner similar to that to be described for the oaks. Only two or three maples have been found which bear evidence of close cropping, not enough from which to draw conclusions (FIG. 1).

Since the thorns, wild apples, oaks and elms are the most numerous and are able to withstand the severe browsing to which they are subjected they are the most interesting types found. The points which I have considered are the forms taken by the several

FIG. 3. The third stage, an erect cone, of the haw. This one was 1.65 m. high and 1.8 m. in diameter at the base. The age might be anywhere from 10 or 20 years up.

species in response to browsing, and the means by which each finally gets beyond the reach of the cattle and so becomes independent.

The ability to withstand constant browsing is only one factor in determining the number of individuals of a species found in a

given pasture. The quantity of seed, the suitability of seed bed and soil, together with other conditions of growth, are quite as important.

The earliest form assumed by the haws as a direct result of the browsing is that of an inverted cone. This particular shape seems to result from the fact that when the tip of a branch is clipped off three or four buds situated short distances below the wound usually start to grow. These buds give rise to branches which elongate at about equal rates, each spreading somewhat from the old axis. Since the cattle trim all the axes which reach the surface and since the branches have a general tendency to grow upwards the plant assumes the form of an inverted cone. Gradually the lower branches are forced downward by the constantly increasing number of new axes formed so that a spheroidal shape may be assumed as shown in FIG. 2. When the lower branches are forced parallel to the ground the tree takes the form of an erect cone (FIG. 3). In grazing the cattle rarely bite the new growth back quite to the dead tips of the older branches, so that there is a gradual increase in size. The conical shape is maintained until the tree is of such a diameter that the center or apex is no longer reached by the cattle. The shoots which are now put out at the apex are free to grow without molestation. The exact duration of the cone stage depends upon the severity of the punishment to which the trees are subjected. In some pastures where the grazing is not severe there may be few or no cones found. In others which are pastured very closely practically all of the haws and apples present are in this condition or show distinct evidence of having passed through it. Under such conditions the plant may be compelled to remain in the cone stage for many years.

When the cattle are no longer able to reach the apex of the cone one or more axes quickly spring out so that we find a closely cropped cone with a loose clump of shoots projecting at its apex. This stage is shown in FIG. 4. In spite of the constant cropping of all new growth within the reach of the cattle, this protected clump rapidly increases both in height and diameter. But since above the reach of the cattle it is free to expand and an hour-glass shape soon results (FIG. 5). Trees in various stages are shown in FIG. 6.

Gradually the free portion of the tree extends beyond the lower branches. The lower portions are now shaded and finally are removed by self pruning until there results the usual rounded

FIG. 4.

FIG. 5.

FIG. 4. This haw had become of so great a diameter that the cattle could no longer reach its apex and so the shoots from this region were able to grow unmolested. This one was 3 m. high and of the same diameter at the base.

FIG. 5. The hour-glass form which is assumed by the haws after the apex has been able to grow for a few years without pruning.

head supported by a single trunk or perhaps by a group of two or three coordinate trunks. However the evidence of the struggle by which the tree has attained its adult shape is seldom quite lost.

FIG. 6. A common sight in pastures whose owner depends upon the cattle rather than the axe.

While the forms taken by the haws are perhaps more striking they are no more characteristic than those assumed by the oaks. Here as a rule only a single axis is developed, from the sides of which short branches are put out. Usually the topmost pair are longer than any of the others or if the browsing is particularly severe there may be a swelling at the top from which several branches arise (FIG. 7). Here the presence of dead stubs, indicating the axes which have been killed by the cattle is a striking feature. The head shown in FIG. 8 is typical of what is usually seen.

FIG. 7. An oak which represents the form typically assumed by this tree when browsed. This one was 12 years of age and had reached a height of 1.35 m. and a diameter of 0.7 m. There were seven annual rings just below the crotch.

The reason for the difference in habit between the oaks and the haws lies, I believe, in the fact that the oaks throw almost their whole strength of growth into a single bud so that when uninterrupted growth has been permitted by the cattle, even for a short time, some one axis will be seen to be much longer than any of the others. While, as has been shown, the growth of the haws is more diffuse, the number of axes increasing with the removal of each tip and all elongating at an approximately equal rate. As a matter of fact it appears that in general the oaks, when able to reach an independent stage at all, do so in fewer years than the haws. On the other hand the haws are able to stand the more severe punishment.

At times, when the terminal bud is greatly interfered with it may not be possible to identify the dominant axis. Evidence of the general tendency is, however, usually furnished by a study of the growth of successive years. Coupled with the emphasized growth of a single bud is the habit of putting out but few branches in response to the removal of the terminal portion of an axis.

The gnarled and bent forms which result from severe browsing may be converted into straight and erect trunks by a stronger growth over all concave surfaces than is found on the convex exposures. This together with the tendency of the growing points to assume the erect position is sufficient to conceal even such a head as the one shown in FIG. 8. During the process of straightening many of the dead stubs decay and are broken off so that they are overgrown. FIG. 9 shows a longitudinal section through a head similar to that shown in FIG. 7, made after this had long

FIG. 8.

FIG. 9.

FIG. 8. When the oaks are severely browsed they are frequently unable to maintain a successful growing axis until after many trials. The result is a globular head, from which project many dead and dying spikelike branches. These later drop off or are overgrown as shown in FIG. 9. About one third natural size.

FIG. 9. A longitudinal section through a head such as is shown in FIG. 8. This has long since ceased to be the point of conflict and the bases of the stubs are being overgrown and the stem straightened as described in the text. About one fourth natural size.

since ceased to be the point of contest and after the main axis had crowded all the others out of the field. The same means of

straightening is used by the other forms studied as well as by those oaks in which the grazing has been less severe. In FIG. 10 is shown a longitudinal section through the axis of an oak which has been subjected to severe browsing, but in which no head had been formed.

In walking through the pastures in which elms are common it is noted that almost all of the trees are 30–80 cm. in height.

FIG. 10. Another instance of straightening, but in this case the browsing has not been so severe and there was no head formed. About one fourth natural size.

This is in many cases due to the fact that these trees commonly grow in the midst of sedges and reach about the height of the sedges before they are noticed by the cattle. They usually reach this height in two or three years and after this are not permitted to increase. Finally the upper portion of the stem dies from the continued cropping and a new shoot appears lower down on the axis or even from the roots and, under the protection of the dead or dying top, soon reaches the height of the latter when it in turn is subjected to severe browsing. There first results a form somewhat resembling that assumed by the oaks, a single stem with a number of side branches, FIG. 11. Finally, if the plant has sufficient vigor, a form is assumed resembling the first, or inverted cone stage, of the haws, FIG. 12. This results from branching and

development of shoots low down on the axis. An intermediate stage is shown in FIG. 13. While this shape appears much later in the elms, it is more accentuated and persistent than in the haws. This is because the branches of the elm have a more marked upward tendency and are not so readily induced to hug the ground as are the branches of the apples and haws. This upward tendency of the branches, together with the fact

FIG. 11.

FIG. 12.

FIG. 11. This elm was in an early stage of the response to browsing. In spite of its age of 18 years, its height was only 61 cm.

FIG. 12. An elm that had been allowed to grow only 32 cm. in 17 years. The close branching and abundance of dead twigs indicate that it is well along in the inverted cone or second stage.

that an axis dies after certain amount of pruning, precludes the possibility of the formation of the spheroidal or of the erect conical form.

The elms are not in general able to reach the independent stage unaided. This is doubtless because they have the habits of growth of the haw but not the haw's vitality and ability to stand pruning. Though the elms are not able to reach independence unaided it must not be inferred that there are no elms which have obtained the independent stage in the pastures. An elm reaching up through

a clump of wild roses, a haw or a spice bush or even from the center of a group of less fortunate elms is a common sight.

In one plot of about 1.5 hectares sixty elms were counted, all of which were unprotected. Of these 90 per cent., or fifty-four, were less than 80 cm. in height and none were beyond the reach of the cattle. The tallest was 1.5 m. In another plot 50 m. square, 121 elms were found, seventeen of which were either protected at the

FIG. 13. An elm at a stage intermediate between those shown in FIGS. 11 and 12. But since it was growing in the open, i.e., was unprotected by sedges, it was only 20 cm. in height though it was 15 years of age.

time or had been at a time which permitted them to escape from the cattle. Of the 104 which were unprotected only two exceeded 1 m. in height and none were beyond the reach of the cattle. 80 per cent. of all the elms in this plot were below 1 m. in height and 23 per cent. enjoyed protection. In the same plot fifty oaks were found with only 56 per cent. below 1 m. and 12 per cent. unprotected.

SUMMARY AND CONCLUSIONS

1. The haws, apples, oaks, and elms are able to withstand constant browsing by cattle for a prolonged period of time.

2. In general other trees in pastures, as the ash, are killed within a few years; or they are avoided by the cattle, as the hickories and other nut-bearing trees.

3. When the tree is able to withstand the cropping for a long period it has good chances of reaching the natural size of the species. This is attained in different ways by the different species:

(*a*) The oaks throw the stress of growth into a single series of buds and so prolong the main axis at the expense of the lateral branches that the tip of this axis may be lifted beyond the reach of the cattle in comparatively few years.

(*b*) The haws and apples put out a large number of approximately equal branches forming a close network about the center of the tree, which is finally so far removed from the attacks of the cattle that it may grow unmolested. This is a much slower method than the one adopted by the oaks but seems to be somewhat surer as judged by the number of successful individuals.

(*c*) The elms have given up the attempt to reach independence without the help of some other plant but because of their persistence many of them are in time given the necessary protection.

4. While thorns are undoubtedly a factor in the escape of some species from the cattle their importance may easily be overestimated; the apples are apparently quite as successful as are the haws but are not provided with this armament

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Kerner has described similar observations on the oak and beech but especially on the larch, as browsed by goats. Doubtless many others have observed related phenomena in pastural regions.

NEW YORK CITY.

Notes on Rosaceae—X

P. A. Rydberg

Rubus Hybrids

Hybrids are rather common in the genus *Rubus*, especially among the blackberries. Numerous hybrids have been admitted in Europe. The only really good attempt made to segregate hybrid forms in America, was that by Mr. Bicknell.* Mr. Bicknell studied these forms in the field and in most cases found the supposed parents growing in the immediate vicinity. I also have studied blackberry hybrids two summers in the Adirondacks, the Catskills, the mountains of southwestern Virginia, western North Carolina, and eastern Tennessee, and around Ottawa, Canada. It is a pity that it never occurred to Mr. Blanchard, who did so much valuable work on the blackberries, to explain the numerous forms as, partly at least, due to hybridity. It would not have been very hard to determine whether or not many of his new species probably had arisen through hybridizing. Mr. Bicknell, without having seen many of Mr. Blanchard's species in the field, reduced nearly all of them into hybrids or into synonyms of older species.

I think that his interpretation was correct in the majority of cases, but that he went too far in his reduction in some others. It is risky to make pronunciations without seeing the species in the field, and my course in the North American Flora was perhaps not so wise. It may have been better to leave many of the supposed species as such than to pronounce them as hybrids, without any better proofs than the finding of intermediate and intergrading characters. No definite conclusion can be had, however, without experimental work in crossing. The only alternative course to pursue would have been to admit all the proposed species as such and to describe twice as many more, most of them without any definite distinctive characters. In such a case, a key would have been impossible to make.

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* Bull. Torrey Club 38: 103–133. 1911.

The following ninety-three tentative hybrids have been recorded. Their essential characters have been pointed out in the North American Flora, but in that work no specimens are cited, except the types of new species and the first records of new hybrids. It is, however, valuable to students of the brambles to know what specimens the monographer regarded as such hybrids. I have, therefore, prepared the following list of specimens.

Rubus acaulis × *stellatus*.

ALASKA: 1885, *Huff;* Copper Center, *Heidman 88*.

Rubus acaulis × *pubescens*. *Rubus propinquus* Richardson is regarded as a synonym of this.

MACKENZIE: Hay River, July 1, 1903, *Preble & Cary 25;* wooded country, *Richardson*.

Rubus arcticus × *pubescens*.*

QUEBEC: Mt. Albert, Gaspé County, 1906, *Fernald & Collins 623a;* Table-top Mountain, *Fernald & Collins 617*.

Rubus arcticus × *saxatilis* (*R. castoreus* Frees). No locality has been recorded on this side of the Atlantic, but it may be expected in northeastern Canada.

Rubus idaeus × *spectabilis*. This is unknown except as a garden plant, and it is natural that it should be so, as *Rubus idaeus* and *R. spectabilis* have no common territory where both grow wild. Indigenous hybrids of *R. spectabilis* and species related to *R. idaeus* have been collected in Alaska, viz., the two following:

Rubus spectabilis × *viburnifolius*.

ALASKA: Lake Clark, 1902, *Gorman*.

Rubus spectabilis × *subarcticus*.

ALASKA: Camp 53, 1899, *Shrader*.

Rubus occidentalis × *rosaefolius*. Known only as a garden hybrid.

Rubus idaeus × *ursinus*. Only known as a spontaneous garden hybrid, which is under cultivation as the Logan Berry.

Rubus idaeus × *phoenicolasius*. *R. Paxii* Focke. Only known as a garden hybrid.

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* In answer to a letter to Dr. Fernald suggesting that the plant collected by him and Mr. Collins was a hybrid, I received the following reply: "I have no doubt that the plants you refer to are hybrids of *Rubus triflorus* and *arcticus*. Such specimens are found in small colonies throughout Gaspé, Newfoundland, and southern Labrador, wherever *R. arcticus* occurs."

Rubus occidentalis × *strigosus* (*R. neglectus* Peck; *Melanobatus neglectus* and *M. michiganus* Greene). This is a rather common hybrid and it would be superfluous to cite specimens. Sometimes it resembles more one parent, sometimes the other. The original *R. neglectus* is most like *R. occidentalis*, while *Melanobatus michiganus* approaches *R. strigosus*.

Rubus occidentalis × *procumbens*. The very interesting plant, which I referred to this hybrid, was collected by Commons nearly forty years ago. Commons recognized it as a hybrid of *R. occidentalis* but made no suggestion of the other parent. This is evidently a member of the *Eubatus* section, apparently to be sought among the dewberries, and most likely *R. procumbens*. Mr. Commons remarks: "I tried to perpetuate this by sowing the seeds at various times, but not one came up."

Rubus leucodermis × *melanolasius*.

BRITISH COLUMBIA: near international boundary between Kettle and Columbia River, *J. M. Macoun 64002;* Chilliwack Valley, *J. M. Macoun 34805;* also *7035* and *69970* from British Columbia.

MONTANA: Belton, 1903, *Umbach 698;* McDonald's Lake, 1909, *M. E. Jones*.

OREGON: Eastern Oregon, 1897, *Cusick 1729*.

WASHINGTON: 1897, *Horner 163*.

Rubus macropetalus × *viburnifolius*. No other specimen but the original one, *Mr. & Mrs. C. Van Brunt 121*, from Glacier, British Columbia, has been seen of this hybrid.

Rubus idaeus × *strigosus*. This is not uncommon in cultivation, but no record of it in a wild state has been made.

Rubus argutus × *cuneifolius*. This was first recognized as a hybrid by Mr. Bicknell. The same form had also been collected by Britton & Hollick, who did not venture to name it. Their specimens were determined as *R. Andrewsianus* by Mr. Blanchard, but the dense grayish pubescence of the under leaves is not found in that species. All the specimens seen are from the sandy coast strip.

NEW JERSEY: Atlantic Highlands, 1906, *Hollick & Britton;* Toms River, 1900, *Bicknell 90*.

Rubus cuneifolius × *floridus*. What I regard as this hybrid is one much resembling the last hybrid but a weaker plant with more curved prickles. Judging from the analogy, it is not improbable that this plant is such a hybrid, as it differs from *R. argutus* × *cuneifolius* in the same characters as does *R. floridus* from *R. argutus*, and both *R. floridus* and *R. cuneifolius* are found in the district where the supposed hybrid has been found. Mr. Ashe distributed it mixed with *R. cuneifolius*.

VIRGINIA: Ocean View, Norfolk, 1898, *Kearney 1212*.

NORTH CAROLINA: Chapel Hill, *Ashe*, mixed with *R. cuneifolius*.

Rubus cuneifolius × *lucidus*. Mr. Nash collected specimens near Eustis, Florida, which resemble *R. cuneifolius* in many respects, but the leaves are larger, more acute and more coarsely serrate. He determined them doubtfully as *R. cuneifolius*. Similar specimens were also collected by Chapman, in Duval County, Florida, together with *R. cuneifolius*. He also has collected *R. lucidus* in the same county.

FLORIDA: Duval County, *Chapman 2832*, mostly; Eustis, 1894, *Nash 70*.

Rubus cuneifolius × *trivialis*. Somewhat similar specimens were collected by Coker at Hartville, South Carolina, but in these the plant is prostrate, the flowers mostly solitary, and in habit it resembles more *R. trivialis*. These specimens I regard as *R. cuneifolius* × *trivialis*.

Rubus canadensis × *sativus*. The specimens which I regard as this hybrid were originally labeled *R. canadensis*, but Mr. Blanchard has afterwards written on the sheets "A var. or form of *R. can.* W. H. B." It is evidently not pure *R. canadensis* for the inflorescence is glandular and the leaflets of the new shoots are broadly cordate and abruptly acuminate as in *R. sativus*.

VERMONT: Windham, June 6, 1903, *Blanchard 265*.

Rubus nigricans × *sativus*. I have no positive evidence that *R. frondisentis* Blanchard is such a hybrid, but the plant combines characters of the two species, and is found where the ranges of the two species overlap. It is also a very local plant and has not been collected except at the original station.

Rubus argutus × *nigrobaccus*. This hybrid was first recog-

nized by Mr. Bicknell, but he used the name *R. allegheniensis* × *argutus*, following Blanchard and Fernald in interpreting *R. allegheniensis*. The plant is not uncommon and the following specimens are referred here.

NEW YORK: Lynbrook, Long Island, 1901, *Bicknell 36;* Elizabethtown, Essex County, 1900, *Macy;* Bronx Park, 1896, *Nash;* Highland Falls, 1910, *Mearns 50.*

MASSACHUSETTS: Quaise, Nantucket Island, 1910, *Bicknell 33;* Shawaukemmo Spring, Nantucket Island, *Bicknell 35;* Canton, near Boston, 1906, *Blanchard 99, set 9.*

VIRGINIA: Rosslyn, 1897, *Kearney.*

CONNECTICUT: Southington, 1904, *Andrews 3.*

PENNSYLVANIA: Tannersville, 1901, *Britton.*

NEW JERSEY: Clifton, 1890, *Nash 900;* Paramus Swamp, Bergen County, *Nash 947;* also *Mackenzie 2086.*

Rubus frondosus × *nigrobaccus*. This was also first recognized as a hybrid by Bicknell, although he included in it specimens which I do not think belong to it but rather to *R. nigrobaccus* × *recurvans*. It was not at all unnatural that he should do so, as he did not recognize *R. recurvans* as a distinct species.

MASSACHUSETTS: Shawaukemmo Spring, Nantucket Island, 1908, *Bicknell 20.*

NEW YORK: Jamaica, Long Island, 1901, *Bicknell 25;* Port Washington, *Bicknell 21, 23;* Franklin Square, *Bicknell 19.*

PENNSYLVANIA: north of Philadelphia, 1906, *Blanchard 100, Set 6;* Lancaster County, 1894, *Ely.*

NEW JERSEY: Succasunna, 1909, *Mackenzie 4123.*

Rubus canadensis × *nigrobaccus*. This hybrid was first recognized by myself when I studied the blackberries in the Catskills, 1906, at Tannersville, where it grew together with *R. nigrobaccus* and *R. canadensis*. I also saw it in the Adirondacks and in southwestern Virginia.

NEW YORK: Tannersville, 1906, *Rydberg 7974;* Little Moose Lake, 1906, *Rydberg 7820a;* Stanford, 1909, *Taylor 712;* Tannersville, 1892, *Vail;* North Harpersfield, *Topping 132.*

MASSACHUSETTS: Tyringham, Berkshire County, 1897, *Vail.*

VERMONT: Grafton, 1902, *Blanchard 177;* Simonsville, *Blanchard 183;* Rutland, 1902, *Eggleston 2884.*

VIRGINIA: White Top Mountain, 1908, *Rydberg 8104;* between Marion and White Top Mountains, *Rydberg 8138.*

NORTH CAROLINA: Graham County, 1897, *Biltmore Herbarium 1307c.*

NEW BRUNSWICK: Grand Falls, *Macoun 21181.*

Rubus amicalis × *nigrobaccus.* Comparing the specimens referred here with *R. canadensis* × *nigrobaccus*, I came to the conclusion that this must be a hybrid of the species mentioned. They were collected by Arthur at Isle au Haut, Maine.

Rubus nigrobaccus × *Randii.* This was first recognized by myself while collecting in the Adirondacks. Both parents grew in the vicinity. Subsequently I thought it was the same as *R. frondisentis* Blanchard, but I have found it is not. None except the original specimens have been seen.

Rubus nigrobaccus × *pergratus.* The following specimens I think belong to this hybrid. They were collected near the type locality of *R. amicalis* × *nigrobaccus. Rubus pergratus* is also common in the region.

MAINE: Isle au Haut, 1909, *Arthur 55, 56.*

Rubus heterophyllus × *nigrobaccus.* I have no evidence that the specimens referred here belong to a hybrid except that the plant combines the habit and glandular pubescence of *R. nigrobaccus* with the leaf cut of *R. heterophyllus.* The original specimens are the only ones seen.

Rubus nigricans × *nigrobaccus.* This I collected at Kingsmere Lake, Quebec, where both *R. nigricans* and *R. nigrobaccus* were growing. I have no doubt but my specimens were of hybrid origin. I cannot distinguish them from specimens of *R. glandicaulis* distributed by Mr. Blanchard. *R. biformispinus* Blanchard I think is also a hybrid of the same two species, though approaching *R. nigricans* more than *R. nigrobaccus.* The following specimens belong here:

QUEBEC: Kingsmere Lake, 1906, *Rydberg 7946.*

NEW BRUNSWICK: Frederickstown, *Blanchard 606.*

MAINE: Yarmouth, 1909, *Blanchard 507;* Brownville, *Blanchard 508;* Bar Harbor, *Blanchard 509;* Calais, *Blanchard 510;* Isle au Haut, 1909, *Arthur 52;* Kennebunk, 1905, *Blanchard 74, Sets 1, 2;* Kennebunkport, 1905, *Blanchard 79.*

NOVA SCOTIA: Granville, 1909, *Blanchard 718, 727;* Yarmouth, *Blanchard 728.*

Rubus nigrobaccus × *vermontanus.* If *R. glandicaulis* is a hybrid between *R. nigrobaccus* and *R. nigricans*, *R. frondisentis* is very likely a hybrid between the former and *R. vermontanus.*

VERMONT: Townshead, 1903 and 1904, *Blanchard 243, 244;* Huntington, 1903, *Blanchard 257.*

Rubus hispidus × *nigrobaccus.* *R. permixtus* Blanchard stands in the same relation to *R. hispidus* as *R. glandicaulis* does to *R. nigricans*, I therefore do not hesitate in regarding it as a hybrid between *R. nigrobaccus* and that species.

VERMONT: Westminster 1902 and 1903, *Blanchard 225, 226, 227, 229;* Putney, 1902, *Blanchard 228;* Westminster, 1903, *Eggleston 3245.*

NEW HAMPSHIRE: Walpole, 1903, *Blanchard 233.*

NOVA SCOTIA: *Macoun 81438, 81439.*

Rubus argutus × *frondosus.* This was first recognized by Mr. Bicknell.

NEW YORK: Rockville Center, Long Island, 1906, *Bicknell 38;* between Yonkers and Mount Vernon, 1902, *Burnham.*

CONNECTICUT: Southington, 1905, *Blanchard 99, set 1;* 1904, *Andrews 27.*

Rubus argutus × *recurvans.* This was included in *R. argutus* × *frondosus* by Bicknell, who did not regard *R. frondosus* and *R. recurvans* distinct.

MASSACHUSETTS: Quaise, Nantucket Island, 1909, *Bicknell 34.*

NEW YORK: Cedarhurst, Long Island, 1910, *Bicknell 37.*

Rubus argutus × *Baileyanus.* This was also segregated out by Mr. Bicknell.

MASSACHUSETTS: below the "Cliff," Nantucket Island, 1910, *Bicknell 40.*

NEW YORK: East Rockaway Bog, Long Island, 1908, *Bicknell 41;* also at Hawlett, *Bicknell 42.*

Rubus argutus × *Enslenii.* This was also recognized by Mr. Bicknell, although he did not publish the same. His specimens closely match the type of *R. ostryifolius* Rydb., which I now do not hesitate in regarding as this hybrid.

NEW YORK: Hempstead Plains, Long Island, 1910, *Bicknell 65;* Lynbrook, *Bicknell 62, 64, 66.*

NEW JERSEY: Highlands, *Britton;* Ogdensburg, 1910, *Mackenzie 4625;* South Amboy, 1905, *Mackenzie 1376.*

VIRGINIA: Norfolk, 1898, *Kearney 1365.*

Rubus argutus × *carpinifolius.* Both Engelmann and Bailey recognized this as a hybrid, regarding one of the parents as *R. trivialis* from which *R. carpinifolius* was not separated at that time. Bailey thought that the other parent was *R. argutus.* Engelmann gave it as *R. villosus*, under which name both *R. argutus* and *R. nigrobaccus* were then known.

MISSOURI: St. Louis, 1863, *Engelmann;* Cahokia, 1863, *Engelmann.*

Rubus floridus × *lucidus.* In the description of *R. persistens* Rydb. two different plants were included. Unfortunately, it happened that the specimen which was assigned as the type evidently belongs to a hybrid of *R. floridus* and a species then unknown. *R. persistens*, therefore, must pass into synonymy.

Rubus carpinifolius × *floridus.* Dr. Engelmann regarded the original specimen of this hybrid as a variety of *R. trivialis.* It is more likely that it is a hybrid of *R. carpinifolius*, which at his time was not distinguished from *R. trivialis*, and *R. floridus*, which is also found in Texas.

TEXAS: Houston, 1842, *Lindheimer.*

Rubus floridus × *frondosus.* Some specimens collected at Bluff Lake, Missouri, by Eggert probably belong to a hybrid between *R. floridus* and *R. frondosus.* The only reason for believing so is that they combine characters of both and were found in a region common to both.

MISSOURI: Bluff Lake, *Eggert.*

TENNESSEE: Knoxville, 1896, *Ruth.*

Rubus Enslenii × *frondosus.* This was first recognized by Mr. Bicknell and well described by him.

NEW YORK: Hempstead Plains, Long Island, 1906, *Bicknell, 48, 49, 70.*

MASSACHUSETTS: Nantucket Island, 1906, *Bicknell 47.*

Rubus frondosus × *procumbens.* I have no definite evidence

that *R. Rossbergianus* is a hybrid of *R. frondosus* and *R. procumbens*, but the habit is intermediate between the two; the leaves resemble in form those of *R. frondosus*, but are harsher; and the stem is light colored, tough and prickly as in *R. procumbens*. Both are found in the region.

CONNECTICUT: Southington, 1905, *Blanchard 89, set 1–3;* Graniteville, *Blanchard 89, set 3;* Canton, *Blanchard 89, set 5;* Southington, 1904, *Andrews 21, 22, 23, 31, 33, 35.*

NEW JERSEY: Tuckerton, *Mackenzie.*

Rubus frondosus × *hispidus.* Also one of Mr. Bicknell's hybrids, collected only at the original station and vicinity, *Bicknell 43, 69.*

Rubus canadensis × *recurvans.* The specimens from which *R. recurvans subrecurvans* was described approach *R. canadensis* L. in so many respects, such as the form of the leaves, the inflorescence, and the weakly developed armature of the stems, that I have regarded it as a hybrid with that species.

MAINE: Kennebunkport, 1905, *Blanchard 71;* York Beach, 1909, *Blanchard 516.*

Rubus Brainerdi × *vermontanus.* The specimens referred to this hybrid were collected at the type station of *R. Brainerdi* and together with it. *R. vermontanus* is common in the region.

VERMONT: Weybridge, *Brainerd;* also 1902, *Eggleston 2894.*

Rubus amicalis × *pergratus.* No specimens except the original ones have been seen.

Rubus argutus × *canadensis.* This was first recorded by myself from southwestern Virginia, but similar specimens have also been collected in the north.

VIRGINIA: road between Marion and White Top Mountain, 1908, *Rydberg 8099;* Chattam Hill Road, 1892, *Small.*

NORTH CAROLINA: Biltmore, 1909, *Crafton & Eggleston, 4416.*

NEW JERSEY: Greenwood Lake, 1907, *Mackenzie 2675;* Ogdensburg, 1910, *Mackenzie 4625.*

Rubus canadensis × *Randii.* This was first recorded by myself from the Adirondacks, where both parents grow.

NEW YORK: Little Moose Lake, 1906, *Rydberg 7818; 7820;* Twin Lakes, *Rydberg 7842;* East Lake, *Rydberg 7861.*

NOVA SCOTIA: Pictou, 1906, *C. B. Robinson 528.*

Rubus canadensis × *pergratus*. Also first recorded by myself at Tannersville, New York, *7960, 7961.*

Rubus Baileyanus × *canadensis*. The specimens originally recorded as this hybrid were collected near an artificial lake or reservoir above Sparta, New Jersey. *R. canadensis* was growing in the neighborhood but *R. Baileyanus* was not collected there. The habit of the plant and the poor fruiting indicate a hybrid of *R. canadensis* and, probably, *R. Baileyanus*. To this belong:

NEW JERSEY: Morris Lake, Sparta, 1906, *Rydberg 7992;* Montague Township, Sussex County, 1909, *Nash;* Midvale, 1908, *Rydberg 8016.*

NOVA SCOTIA: *Macoun 81433, 81431.*

Rubus elegantulus × *nigrobaccus*. *Rubus flavinanus* Blanchard evidently represents this hybrid. The plant is decidedly intermediate between the two. None except Blanchard's specimens have been seen.

Rubus Baileyanus × *nigrobaccus*. This was first recognized as a hybrid by Mr. Bicknell, who, however, did not publish the same. The following specimens belong here:

NEW YORK: Smithtown, Long Island, 1910, *Bicknell 17, 24.*

PENNSYLVANIA: Presque Isle, Erie, *Otto Kuntze 2671.*

NEW JERSEY: Midvale, 1908, *Rydberg 8017.*

Rubus Baileyanus × *procumbens*. This has been known for fifteen years or more and is even in cultivation, but it was first regarded as a variety of *R. procumbens*, and later as a distinct species under the name *R. roribaccus*. Mr. Bicknell was the first one to recognize it as a hybrid. Some of his specimens match very closely the original ones distributed by Professor Bailey.

MASSACHUSETTS: Nantucket Island, 1910, *Bicknell 8.*

NEW YORK: Cedarhurst, Long Island, 1910, *Bicknell 6;* Aqueduct, 1905, *Bicknell 7.*

NEW JERSEY: Ledgewood, 1909, *Mackenzie 4127;* Succasunna, *Mackenzie 4126.*

VIRGINIA: Glade Springs, 1908, *Rydberg 8148;* Fairfax, 1906, *Blanchard 101, set 3.*

PENNSYLVANIA: Willow Grove Park, 1906, *Blanchard 101, set 2;* Lancaster, *Blanchard 101, set 1.*

CONNECTICUT: Southington, 1906, *Blanchard 101, set* 5½.

MISSOURI: Little Blue Tank, 1897, *Mackenzie 210.*

IOWA: Papoose Creek, 1894, *Mackenzie 681.*

Rubus Baileyanus × *frondosus.* First segregated by Mr. Bicknell.

MASSACHUSETTS: Quaise, Marcy's Pond, below the "Cliff," and Squam, Nantucket Island, 1910, *Bicknell 85, 86, 88, 87, 84.*

NEW JERSEY: Budd's Lake, 1905, *Eggleston 0;* Mt. Arlington, 1905, *Mackenzie 1402;* Stanhope, *2085;* Berkeley Heights, *2047.*

Rubus Baileyanus × *hispidus.* This was at first included in *R. hispidus* × *procumbens* by Bicknell. He, however, determined his Long Island material as *R. Baileyanus* × *hispidus.*

NEW YORK: Aqueduct, Long Island, 1905, *Bicknell 73.*

NEW JERSEY: near Musconetcony River, 1906, *Mackenzie 2107.*

MASSACHUSETTS: Reed Pond, Nantucket Island, 1910, *Bicknell 75;* Reading, 1897, *Kingman.*

Rubus Baileyanus × *carpinifolius.* Another plant collected by Eggert at Bluff Lake, Missouri, in 1878 must be, on account of the combination of characters, a hybrid between *R. Baileyanus* and *R. carpinifolius*, which both grow in the region.

Rubus arenicola × *hispidus.* The original specimens are the only ones seen of this hybrid.

Rubus nigrobaccus × *plicatifolius.* The specimen referred to this hybrid (*Blanchard 516*, sheet 1), was labeled by Mr. Blanchard *R. recurvans* var. *subrecurvans*, which variety I regard as a hybrid between *R. recurvans* and *R. canadensis;* but this number evidently does not belong there. The glandular pubescence of the inflorescence and the cut of the leaves in the specimens mentioned indicating *R. nigrobaccus* blood. The pubescence and the plication of the leaves suggest *R. plicatifolius.*

Rubus nigricans × *plicatifolius.* I regard *R. multiformis* Blanchard as a hybrid of *R. nigricans* and *R. plicatifolius.*

NOVA SCOTIA: Yarmouth, 1909, *Blanchard 724;* Annapolis *Blanchard 726;* Kentville, *Blanchard 725.*

MAINE: Bar Harbor, 1909, *Blanchard 512;* Kennebunkport, 1905, *Blanchard 80.*

QUEBEC: *Macoun 67904.*

Rubus canadensis × *plicatifolius.* The almost unarmed stem of *Rubus multiformis delicatior* Blanchard indicates a hybrid of *R. canadensis.* The plicate leaves suggest *R. plicatifolius.*

MAINE: Kennebunkport, 1905, *Blanchard 81.*

NOVA SCOTIA: Halifax, *Macoun 81426.*

Rubus hispidus × *plicatifolius.* *Rubus semierectus* Blanchard I take as a hybrid. The small flowers, bristly stem and broad leaflets suggest *R. hispidus*, the pubescent strongly veined and subplicate leaflets, *R. plicatifolius.*

MAINE: Kennebunk, 1905, *Blanchard 67.*

NEW YORK: vicinity of Tannersville, 1891, *Vail.*

NOVA SCOTIA: *Macoun 5792, 19076.*

Rubus heterophyllus × *recurvans.* No other specimens than those cited in the North American Flora, viz., *Blanchard 256*, from Huntington Hills, Massachusetts, have been seen which may be referred to this hybrid.

Rubus argutus × *flagellaris.* This as well as all the other hybrids of *R. flagellaris* were discovered by Mr. Bicknell. For specimens and notes see his paper in the Bull. Torrey Club **38**: 103–133, 1911. The other hybrids are *Rubus flagellaris* × *frondosus*, *R. flagellaris* × *procumbens*, *R. Baileyanus* × *flagellaris*, *R. flagellaris* × *hispidus* and *R. flagellaris* × *Enslenii.*

Rubus nigrobaccus × *procumbens.* This was first recognized by Mr. Bicknell, but under the name *R. allegheniensis* × *procumbens.*

NEW YORK: Merrick, Long Island, 1910, *Bicknell 30;* Hewlett, *Bicknell 28;* Lynbrook, *Bicknell 26.*

MASSACHUSETTS: Wauwinet, Nantucket Island, 1910, *Bicknell 27.*

Rubus argutus × *procumbens.* This was also first recognized as a hybrid by Bicknell. *Rubus multispinus* Blanchard matches Bicknell's specimens very closely.

NEW YORK: Rockville Center, Long Island, 1909, *Bicknell;* Hewlett, *Bicknell 68;* Lawrence, *Bicknell 67.*

MASSACHUSETTS: Nantucket Island, 1899, *Bicknell 29;* 1910, *Bicknell, 82, 83;* Reheboth, 1906, *Blanchard 96, set 2;* Plymouth, 1906, *Blanchard 96, set 3.*

RHODE ISLAND: Rocky Point, 1906, *Blanchard 96, set 1.*

Rubus procumbens × *recurvans.* Many specimens from Connecticut resemble *R. procumbens* closely, but are more pubescent and with the leaves of the floral branches more incised. These I have regarded as hybrids with *R. recurvans.* They are:

CONNECTICUT: Southington, 1904, *Andrews 29, 28, 41, 61, 37, 34, 30;* Plainville, 1903, *Blanchard 222;* Winsted *Blanchard, 259.*

MASSACHUSETTS: Southwick, 1903, *Blanchard 253.*

Rubus pergratus × *procumbens.* *Rubus recurvicaulis* Blanchard seems to me a hybrid of *R. pergratus* and *R. procumbens*, combining characters of both. I have seen no specimens except those distributed by Mr. Blanchard.

Rubus canadensis × *procumbens.* *Rubus recurvicaulis inarmatus* stands to *R. canadensis* as *R. recurvicaulis* does to *R. pergratus*, and I believe also this to be a hybrid.

MAINE: Kennebunk, 1905, *Blanchard 67, 69.*

NOVA SCOTIA: North Sidney, 1907, *C. B. Robinson 616.*

Rubus hispidus × *procumbens.* This was first recognized by Mr. Bicknell. The following specimens belong here:

NEW YORK: Cypress Hill, 1905, *Bicknell 74.*

VERMONT: Londonderry, 1903, *Blanchard, 246;* Newfane, 1902, *Blanchard 186.*

NOVA SCOTIA: Boylston, 1890, *Chas. Hamilton, 19985.*

NEW JERSEY: Mt. Arlington, 1905, *Mackenzie 1404;* also 1904, *Mackenzie 903.*

Rubus Baileyanus × *Enslenii.* Also one of Mr. Bicknell's hybrids.

MASSACHUSETTS: Nantucket Island, 1908, *Bicknell 52, 54, 55.*

CONNECTICUT: New Haven, 1895, *Helen Ingersoll.*

NEW YORK: Woodmere, 1904, *Bicknell 56.*

DISTRICT OF COLUMBIA: Riverdale, 1901, *Steele.*

VIRGINIA: Marion, *N. L. & E. G. Britton & A. M. Vail.*

Rubus Enslenii × *procumbens,*

Rubus Baileyanus × *Enslenii,*

Rubus Enslenii × *flagellaris,* and

Rubus Enslenii × *hispidus.* Of these four hybrids, I have seen none but Mr. Bicknell's specimens. See Bull. Torrey Club 38: 130–131. 1911.

Rubus argutus × *nigricans*. I cannot distinguish *R. adscendens* Blanchard from Mr. Bicknell's hybrid. The following specimens belong here:

NEW YORK: Smithtown, Long Island, 1808, *Bicknell 89*.

NEW JERSEY: Allamuchy Mountains, 1906, *Mackenzie 2108, 2300;* Succasunna, 1909, *Mackenzie 4153*.

CONNECTICUT: Southington, 1906, *Blanchard 90;* 1903, *Blanchard 262, 224;* Londonderry, *Blanchard 246;* 1904, *Andrews 53, 57, 56*.

MASSACHUSETTS: Essex County, *Oakes*.

Rubus frondosus × *nigricans*. From this I cannot separate *Rubus abbrevians* Blanchard. The following specimens belong here:

MASSACHUSETTS: Long Pond and Trot's Swamp, Nantucket Island, 1910, *Bicknell 31, 32*.

CONNECTICUT: Southington, 1906, *Blanchard 95*.

VERMONT: Windham, 1904, *Blanchard 57*.

PENNSYLVANIA: Germantown, *Meehan 8679*.

Rubus nigricans × *recurvans*. *R. semisetosus* Blanchard I regard as a hybrid between *R. nigricans* and *R. recurvans*. The following specimens belong here:

CONNECTICUT: Southington, 1903, *Blanchard 201, 202, 225;* Londonderry, *Blanchard 247;* Plainville, 1906, *Blanchard 91, set 1;* also 1903, *261, 203*.

RHODE ISLAND: Rocky Point, 1906, *Blanchard 91, set 3*.

NOVA SCOTIA: Sable Island, *Macoun 21193, 21183* (these specimens are doubtful).

Rubus amicalis × *nigricans*. *Rubus tardatus* Blanchard is probably also a hybrid, the parents being *R. amicalis* and *R. nigricans*. Mr. Blanchard's specimens are the only ones seen.

Rubus nigricans × *pergratus*. In my opinion *R. peculiaris* Blanchard is also a hybrid, viz., of *R. nigricans* and *R. pergratus*. Besides Mr. Blanchard's specimens the following belong here:

QUEBEC: vicinity of Montmorency Falls, 1905, *Macoun 67904, 67905*.

Rubus canadensis × *nigricans*. *Rubus junceus* Blanchard is probably also a hybrid. Besides the specimens distributed by Mr. Blanchard, the following are referred to it.

ONTARIO: Cranberry Lake, Algonquin Park, 1900, *Macoun 24696a.*

MAINE: Sangerville, 1895, *Fernald 244.*

Rubus nigricans × *Randii.* Only the specimens of the original collection have been recorded.

Rubus Baileyanus × *nigricans.* This was first recognized by Mr. Bicknell. C. C. Curtis's specimens have much narrower leaflets and are doubtfully referred to it.

NEW YORK: Hempstead Plains, 1910, *Bicknell 15;* between Yonkers and Mount Vernon, 1903, *C. C. Curtis;* Van Courtlandt Park, 1896, *Bicknell.*

CONNECTICUT: Plainville, 1904, *Andrews 26;* Southington, 1903, *Blanchard 237* (determined as *R. semisetosus*).

Rubus flagellaris × *nigricans.* This was collected by Mr. Bicknell, who included it in *R. nigricans.* The following specimens so named I refer to the hybrid instead.

MASSACHUSETTS: Little Neck, Millbrook Swamp and Long Pond, Nantucket Island, 1910, *Bicknell X, XX, XXX.*

Rubus nigricans × *procumbens.* This was also recognized as a hybrid although he did not describe the same. The following specimens belong to it:

NEW YORK: East Hempstead, Long Island, 1910, *Bicknell 16;* Jamaica, 1906, *Bicknell 18.*

CONNECTICUT: Plainville, 1904, *Andrews 55;* Southington, *Andrews 54, 57, 58, 59, 62.*

VERMONT: Londonderry, 1903, *Blanchard 245* (referred doubtfully to *R. vermontanus*).

NOVA SCOTIA: *Macoun 81425;* Sable Island, *Macoun 21193.*

Rubus nigricans × *vermontanus. Rubus vermontanus viridifolius* has glandular hispid inflorescence and I therefore believe it contains some *R. nigricans* blood in it. I therefore regarded it as a hybrid. Many specimens referred to *R. setosus* by Blanchard belong here:

VERMONT: Marlboro, 1902, *Blanchard 191;* Woodstock, 1910, *Britton;* Stockbridge, 1897, *Eggleston;* West Windham, 1904, *Blanchard 59, set 1;* Stratton, *59, Blanchard, set 2;* Rutland, 1899, *Eggleston 1228.*

NEW YORK: Tannersville, 1906, *Rydberg 7954.*
NEW HAMPSHIRE: Alstead, 1903, *Blanchard 236, 234, 235.*
MAINE: Biddeford, 1905, *Blanchard 86.*
QUEBEC: East Templeton, 1903, *Macoun 59963.*

Rubus hispidus × *nigricans.* Mr. Bicknell found this very variable, sometimes approaching one parent, sometimes the other. My observations agree very well with his. Often the plant resembles a robust *R. hispidus*, but with the leaflets of the new shoots having a tendency often to be five instead of three. It is then *R. hispidus major* Blanchard. Sometimes it resembles more *R. nigricans* in habit. If the leaflets of the new shoots happen to be only three, it is *R. trifrons* Blanchard. The following represent *R. hispidus major:*

CONNECTICUT: Southington, 1904, *Andrews 60;* Botsford, 1897, *Eames.*

MAINE: Kennebunkport, 1905, *Blanchard 84;* Kennebunk, *Blanchard 85.*

NOVA SCOTIA: Cape Breton, 1901, *Howe & Lang 748;* Pictou, 1907, *C. B. Robinson 574, 494.*

MASSACHUSETTS: 1879, *Perkins.*

PENNSYLVANIA: Pocono Plateau, 1893, *Britton.*

NEW YORK: Tannersville, 1908, *Rydberg 8037.*

Specimens resembling *R. trifrons* are the following:

VERMONT: West Wadsboro, 1904, *Blanchard 55;* Stratton, 1902, *Blanchard 198.*

NEW YORK: Tannersville, 1906, *Rydberg 7957, 7954* (one sheet of this number Mr. Blanchard has determined as *R. hispidus*, the other as *R. setosus.* Both were from the same plant).

The following are intermediate or cannot be referred to either form:

VERMONT: North Windham, 1903, *Blanchard 251* (named *R. setosus*); Stratton, 1902, *Blanchard 199.*

NEW JERSEY: Musconetcong River, *Mackenzie 2108, 2300.*

NEW YORK: Tannersville, 1906, *Rydberg 7956.*

CONNECTICUT: Southington, 1904, *Andrews 60.*

Rubus hispidus × *vermontanus.* In my mind there is very little doubt but *R. jacens* Blanchard represents this hybrid. A

few specimens referred to *R. trifrons* by Blanchard apparently belong here also. The following specimens have been recorded:

VERMONT: Townsend, 1903, *Blanchard 241;* Stratton, 1904, *Blanchard 55, set 2*; South Londonderry, 1903, *Blahchard 250.*

NEW HAMPSHIRE: Alstead, 1903, *Blanchard 232, 231.*

Rubus cubitans Blanchard seems to me to be a mixture. The flowering branches and the new shoots were not collected at the same time. Do they belong to the same plant? The floral branches seem to me as typical *R. hispidus*, though with more flowers than usual. The leaflets of the new shoots have the texture of those of *R. hispidus* but the form of those of *R. vermontanus*. They may very well represent a hybrid.

Rubus argutus × *hispidus*. This was first recognized by Mr. Bicknell, who, however, did not characterize the same. Only Bicknell's specimens are known.

Rubus canadensis × *hispidus*. The only specimens seen, which may be referred to this hybrid, are the original ones cited in the North American Flora.

NOVA SCOTIA: Le Have River, *Macoun 81436a.*

NEW YORK BOTANICAL GARDEN

INDEX TO AMERICAN BOTANICAL LITERATURE

1912–1915

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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Anastasia, G. E. Araldica nicotinae. Boll. Tecnico Coltiv. Tabac. **13**: 51–220. *pl. 1–82*. Au 1914. [Illust.]

An appendix to this number containing 60 plates additional, variously labeled A–Z, issued separately S 1914.

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Appel, O. The relations between scientific botany and phytopathology. Ann. Missouri Bot. Gard. **2**: 275–285. 17 My 1915.

Atkinson, G. F. Phylogeny and relationships in the Ascomycetes. Ann. Missouri Bot. Gard. **2**: 315–376. *f. 1–10*. 17 My 1915.

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Belling, J. Inheritance of pod pubescence and partial sterility in *Stizolobium* crosses. Rep. Florida Agr. Exp. Sta. 1914: lxxxi-cv. *f. 1–9*. Ap 1915.

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Blake, S. F. An *Atriplex* new to North America. Rhodora **17**: 83–86. *f. 1, 2*. 28 Ap 1915.

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Includes *Pedilanthus latifolius* Millsp. & Britton, *Tabebuia lucida*, *Riccia Brittonii* Howe, and *Riccia violacea* Howe, spp. nov.

Cameron, F. K. Potash from kelp. U. S. Dept. Agr, Soils Rep. 100: 1–122. *pl. 1–40 + f. 1 + maps A—G, 1–61.* 10 Ap 1915.

Includes chapters by Crandall, Rigg, and Frye here indexed separately.

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("Ex. comm. Linh. Telegr. Estrat. de Matto Grosso ao Amazonas. Annexo no. 5. Botanica Parte I. Dec. 1910, 71 pp., 63 tab.")

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Includes *Polypodium mollendense, Cheilanthes ornatissima, C. incarum, Notholaena Brackenridgei, N. arequipensis,* and *Dryopteris Rosei,* spp. nov.

Meyer, R. *Echinopsis cinnabarina* Lab. Monats. Kakteenk. **25**: 20–23. Mr 1915.

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Pierce, R. G. The present status of the chestnut bark disease in Massachusetts. Arborea **1**: 8, 9. My 1914.

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Includes eleven new species and one new genus (*Corollonema*).

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Urban, I. Sertum antillanum. I. Repert. Sp. Nov. **13**: 444–459. 31 D 1914.

Includes new species in *Piper* (1), *Phoradendrum* (1), *Coccoloba* (4), *Portulaca* (1), *Magnolia* (1), *Phyllanthus* (7), *Croton* (6), and *Rhamnidium* (1).

Vaupel, F. Peruanische Kakteen. Monats. Kakteenk. **24**: 154–157. 15 N 1914; **24**: 161–177. 15 D 1914. [Illust.]

STOUT: HIBISCUS OCULIROSEUS

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Vol. 42 No. 9

BULLETIN

OF THE

TORREY BOTANICAL CLUB

SEPTEMBER, 1915

Studies of West Indian plants—VII

NATHANIEL LORD BRITTON

39. THE GENUS SCLERIA BERG. IN CUBA

The last previous treatment of the Cuban species is that of Mr. C. B. Clarke in Urban, Symb. Ant. **2**: 8–169. 1900.

A. Hypogynium present.
1. Hypogynium not covered with a white rough crust.
a. Margin of the hypogynium neither ciliate nor fimbriate [see *S. cubensis*].
* Roots fibrous; rootstocks none or very short.
Achene reticulated or irregularly ridged; plants slender. 1. *S. setacea.*
Achene smooth; plants stout. 2. *S. lacustris.*
** Perennials, with rootstocks. [Rootstock in *S. setuloso-ciliata* short, or perhaps none.]
Achene smooth.
Ligule large, its margin scarious or callous.
Climbing; branched; pilose. 3. *S. secans.*
Erect; simple; glabrous. 4. *S. catalinae.*
Ligule short, small; culms erect or spreading.
Culms slender; leaves relatively smooth.
Panicle red-purple; achene purple to white. 5. *S. melaleuca.*
Panicle brown-green; achene white.
Achene depressed-globose. 6. *S. pterota.*
Achene longer than thick.
Leaves 2–4 mm. wide. 7. *S. Wrightiana.*
Leaves 8–15 mm. wide. 8. *S. setuloso-ciliata.*
Culms stout; leaves very rough. 9. *S. scindens.*
Achene verrucose, reticulated or papillose.
Achene papillose. 10. *S. ciliata.*

[The BULLETIN for August (**42**: 429–486. *pl. 26, 27*) was issued September 22, 1915.]

Achene verrucose or reticulated.
Achene reticulated; hypogynium supporting 3 deeply 3-lobed tubercles. 11. *S. Curtissii.*
Achene verrucose-reticulated; hypogynium 3-lobed.
Glabrous or nearly so. 12. *S. stereorrhiza.*
Leaves and sheaths densely pilose-pubescent. 13. *S. pilosissima.*

b. Margin of the hypogynium ciliate, ciliolate or fimbriate [nearly or quite eciliate in *S. cubensis*].
Margin of the hypogynium ciliate or ciliolate.
Achene 2 mm. long or less. 14. *S. microcarpa.*
Achene 2.5–3 mm. long.
Style-base black, persistent; achene ellipsoid. 15. *S. mitis.*
Style-base pale, deciduous; achene subglobose.
Leaves about 3 mm. wide. 16. *S. phylloptera.*
Leaves 8–16 mm. wide.
Margin of the hypogynium ciliolate or eciliate. 17. *S. cubensis.*
Margin of the hypogynium densely long-ciliate. 18. *S. Grisebachii.*
Margin of the hypogynium 3-lobed, the lobes laciniate or fimbriate. 19. *S. porphyrorrhiza.*

2. Hypogynium covered with a white rough crust. 20. *S. havanensis.*

B. Hypogynium none, or obsolete.
Annuals with fibrous roots; inflorescence glomerate-spicate.
Achene smooth. 21. *S. distans.*
Achene verrucose, reticulated or cancellate.
Bracts strongly ciliate; achene cancellate. 22. *S. pinetorum.*
Bracts glabrous; achene verrucose or verrucose-reticulated.
Inflorescence simply glomerate-spicate. 23. *S. verticillata.*
Inflorescence branched. 24. *S. Liebmanni.*
Perennial by rootstocks.
Inflorescence glomerate-spicate; achene smooth. 25. *S. hirtella.*
Inflorescence not glomerate-spicate.
Panicle loose. 26. *S. lithosperma.*
Inflorescence subcapitate.
Achene 2–3 mm. long, with 2 pits on each side of the 3-angled base. 27. *S. gracilis.*
Achene 4 mm. long, without pits. 28. *S. Baldwinii.*

1. SCLERIA SETACEA Poir. in Lam. Encycl. 7: 4. 1806

Scleria hemitaphra Steud. Syn. Pl. Cyp. 169. 1855.

Scleria Torreyana Walp. Ann. 3: 696. 1853.

Scleria dictyocarpa Griseb. Cat. Pl. Cub. 259. 1866.
Scleria debilis C. Wright; Sauvalle, Anales Acad. Habana 8: 154. 1872.
S. reticularis pubescens Britton, Ann. Lyc. N. Y. 3: 232. 1885.

Savannas and along streams, Pinar del Rio:—southern United States; Porto Rico; tropical continental America.

2. SCLERIA LACUSTRIS C. Wright; Sauvalle, Anales Acad. Habana 8: 152. 1872

Lagoons near Pinar del Rio. Recorded by Clarke from French Guiana and from Java.

3. SCLERIA SECANS (L.) Urban, Symb. Ant. 2: 169. 1900

Schoenus secans L. Syst. ed. 10, 865. 1759.
Scleria reflexa HBK. Nov. Gen. 1: 232. 1815.

Mountain woodlands, Oriente:—Haiti to Martinique and Trinidad; Jamaica; tropical continental America.

My examination of the type specimen of *Schoenus secans* L., in the herbarium of the British Museum of Natural History, some years ago, showed that it was the same as *Scleria reflexa* HBK., and not the same as *Scleria Flagellum-nigrorum* Berg.

4. **Scleria catalinae** sp. nov.

Perennial by thick rootstocks; culm stout, sharply 3-angled, roughish on the angles, glabrous, about 1.3 m. high. Leaves glabrous, slightly roughish-margined, 3–5 dm. long, 1–2.3 cm. wide, 3-nerved, attenuate-acuminate, the ligule triangular-ovate to triangular-lanceolate, acute or acuminate, many-striate, narrowly callous-margined, 2 cm. long or less; panicle about 5 dm. long, of few, distant, slender branches, the staminate and pistillate spikelets intermixed; staminate spikelets oblong, 3–4 mm. long; achene ovoid, purplish, smooth, shining, acute, 2 mm. long, the style-base persistent; hypogynium obconic, 1 mm. long, glabrous, its base rounded, its 3 rounded lobes appressed.

Santa Catalina, Pinar del Rio (*Van Hermann 3272*).

By its very large ligule related to *S. arundinacea* Kunth, but the achene and inflorescence are quite different, resembling those of *S. cubensis* Boeckl.

5. SCLERIA MELALEUCA Schl. & Cham. Linnaea **6**: 29. 1831

Savannas and banks, Camaguey; Havana; Pinar del Rio:—Jamaica; Porto Rico; St. Vincent to Trinidad; continental tropical America. The West Indian specimens here referred are not very different from the following species.

6. SCLERIA PTEROTA Presl in Oken, Isis **21**: 268. 1828

Scleria pratensis Nees in Mart. Fl. Bras. **2**[1]: 179. 1843.
Scleria Ottonis Boeckl. Linnaea **38**: 490. 1874.

Woodlands and banks, Santa Clara; Havana; Pinar del Rio; Isle of Pines:—Haiti to St. Thomas and Barbadoes; Jamaica; continental tropical America.

7. SCLERIA WRIGHTIANA Boeckl. Flora **64**: 79. 1881

Scleria elata C. Wright; Sauvalle, Anales Acad. Habana **8**: 153. 1872. Not Thwaites.

Pine-lands and savannas, Pinar del Rio and Isle of Pines. Endemic.

8. SCLERIA SETULOSO-CILIATA Boeckl. Flora **65**: 30. 1882

Wet situations, Matanzas; Havana; Isle of Pines:—Guatemala.

9. SCLERIA SCINDENS Nees, Linnaea **9**: 303. 1834

Mountain woodlands, Oriente:—Tortola; St. Kitts to St. Vincent.

10. SCLERIA CILIATA Michx. Fl. Bor. Am. **2**: 167. 1803

Scleria Elliottii Chapm. Fl. S. U. S. 531. 1860.

Barrens and pinelands, Santa Clara; Matanzas; Pinar del Rio; Isle of Pines:—southeastern United States; Santo Domingo.

11. SCLERIA CURTISSII Britton; Small, Fl. S. E. U. S. 200, 1328. 1903

? *Scleria pauciflora effusa* Clarke in Urban, Symb. Ant. **2**: 143. 1900.

Savannas, Pinar del Rio and Isle of Pines:—Florida. Referred by Wright, by Clarke and formerly by me to *S. pauciflora* Muhl.

12. SCLERIA STEREORRHIZA C. Wright; Clarke in Urban, Symb. Ant. **2**: 147. 1900

Scleria bracteata Griseb. Cat. Pl. Cub. 249. 1866. Not Cav.
Scleria bracteata angustata Griseb. *loc. cit.* 1866.
Scleria stereorrhiza major Clarke in Urban, *loc. cit.* 1900.

Along streams and on hillsides, Santa Clara; Havana; Pinar del Rio. Endemic.

13. **Scleria pilosissima** sp. nov.

Perennial by short, branched rootstocks; culms rather slender, but stiff, sharply 3-angled, loosely pilose, simple, 3–4 dm. high. Leaves roughish-margined, 1–2 dm. long, 2–4 mm. wide, acuminate, stiff, densely pilose, the midvein prominent beneath; clusters of spikelets 1 or 2, pilose, 2–4 cm. long, the staminate and pistillate spikelets intermixed; scales lanceolate, acute, pubescent; achene subglobose, 2–2.5 mm. in diameter, transversely verrucose, pubescent, obtuse, abruptly apiculate; hypogynium with 3 rounded, appressed lobes.

Sunny hillsides among rocks, between Punta Gorda and Woodfred, Oriente, Cuba, 400–500 m. alt. (*Shafer 3099*).

Related to *S. stereorrhiza* C. Wright.

14. SCLERIA MICROCARPA Nees, Linnaea **9**: 302. 1834

Scleria foliosa C. Wright; Sauvalle, Anales Acad. Habana **8**: 154. 1872. Not A. Rich.
Scleria microcarpa foliosa Clarke in Urban, Symb. Ant. **2**: 149. 1900.

River banks, Pinar del Rio and Isle of Pines:—Porto Rico; Guadaloupe; Jamaica; Trinidad; continental tropical America.

15. SCLERIA MITIS Berg. Vet. Akad. Handl. Stockh. **26**: 145. 1865

Scleria Eggersiana Boeckl. Cyp. Nov. **2**: 41. 1890.

Pinal de Sta. Ana collected by Eggers, according to Clarke:—Porto Rico; Guadeloupe; Martinique; St. Vincent; Trinidad: continental tropical America.

16. SCLERIA PHYLLOPTERA C. Wright; Griseb. Cat. Pl. Cub. 248. 1866

Scleria microcarpa angustifolia Boeckl. Flora **64**: 79. 1881.

Moist savannas and borders of lagoons, Santa Clara; Pinar del Rio. Endemic.

17. SCLERIA CUBENSIS Boeckl. Cyp. Nov. 2: 42. 1890

Scleria microcarpa subeciliata Clarke in Urban, Symb. Ant. 2: 149. 1900

Banks and woodlands, mountains of Oriente and Santa Clara:—Hispaniola; Porto Rico; Jamaica.

18. SCLERIA GRISEBACHII Clarke in Urban, Symb. Ant. 2: 150. 1900

Bogs, Santa Clara; Havana:—Hispaniola; Antigua; Dominica; Martinique; Jamaica.

19. SCLERIA PORPHYRORRHIZA C. Wright; Sauvalle, Anales Acad. Habana 8: 155. 1872

Pinelands, Pinar del Rio. Recorded by Clarke from Brazil.

20. **Scleria havanensis** sp. nov.

Rootstocks stout, horizontal, 3–4 cm. long, about 6 mm. thick. Culms many, slender, trigonous, nearly smooth, about 5 dm. long; leaves nearly smooth, narrow, 1–1.5 mm. wide; inflorescence a single small cluster of intermixed staminate and pistillate spikelets; achene white, ridged-reticulated, globose-oblong, rounded, 2 mm. long; hypogynium low, obscurely 3-lobed, covered with a rough whitish crust.

Coca Hill, Campo Florida, province of Havana (*Brother Leon 4731*).

21. SCLERIA DISTANS Poir. in Lam. Encycl. 7: 4. 1806

Scleria tenella Griseb. Cat. Pl. Cub. 249, in part. 1866. Not Kunth.

? *S. hirtella pauciliata* Britton, Ann. N. Y. Acad. Sci. 3: 236. 1885.

Cuba, collected by Wright:—Hispaniola; Porto Rico; St. Thomas; Guadeloupe.

22. **Scleria pinetorum** sp. nov.

Annual, with many finely fibrous roots; culms slender, erect, 2–4 dm. high. Leaves grass-like, pubescent with spreading hairs, 1–2 mm. wide; inflorescence glomerate-spicate, 5–8 cm. long;

bracts linear-lanceolate, ciliate, 6 mm. long or less; achene globular, white, deeply reticulated, about 1.5 mm. in diameter, with a row of pits at its base, the short base 3-angled.

Pine-lands and savannas, Pinar del Rio. Type collected between Candelaria and Artemisa (*Wilson 1724*).

Previously referred by me (Ann. N. Y. Acad. Sci. 3: 236) to *S. interrupta* A. Rich., of Guiana, which now seems to me to be distinct.

23. SCLERIA VERTICILLATA Muhl.; Willd. Sp. Pl. 4: 317. 1805

Pinelands, Pinar del Rio; Isle of Pines:—eastern United States; New Providence, Bahamas.

24. SCLERIA LIEBMANNI Steud. Syn. Pl. Cyp. 179. 1855

Scleria tenella Griseb. Cat. Pl. Cub. 249, in part. 1866. Not Kunth.

Scleria luzulaeformis C. Wright; Sauvalle, Anales Acad. Habana 8: 156. 1872.

Savannas near San Juan de Buena Vista, jurisdiction of Bayamo, according to Sauvalle (*Wright 3418*, in part); Mexico to Brazil.

25. SCLERIA HIRTELLA Sw. Prodr. 19. 1788

Scleria nutans Kunth, Enum. 2: 352. 1837.

Moist grounds, Oriente; Santa Clara; Pinar del Rio; Isle of Pines,—southern United States; Haiti; Porto Rico; Jamaica; Trinidad; continental tropical America; tropical Africa.

26. SCLERIA LITHOSPERMA (L.) Sw. Prodr. 18. 1788

Scirpus lithospermus L. Sp. Pl. 51. 1753.
Scleria filiformis Sw. Prodr. 19. 1788.
S. lithosperma filiformis Britton, Ann. N. Y. Acad. Sci. 3: 231. 1885.

Woodlands and thickets, all provinces:—Florida; Bahamas; West Indies; tropical continental America; Old World tropics.

27. SCLERIA GRACILIS Ell. Bot. S. C. & Ga. 2: 571. 1824

Moist savannas, Pinar del Rio:—southeastern United States.

28. SCLERIA BALDWINII (Torr.) Steud. Syn. Pl. Cyp. 175. 1855

Hypoporum Baldwinii Torr. Ann. Lyc. N. Y. 3: 382. 1836.

Border of lagoon, Laguna Santa Maria, Pinar del Rio:—southeastern United States.

FURTHER STUDIES OF BADIERA DC.

Since the publication of my former paper on this genus (Bull. Torrey Club 37: 360–363. 1910), additional specimens which have come to hand afford the following notes and descriptions.

1. BADIERA PENAEA (L.) DC.

Professor Urban has informed me that my opinion that this is identical with *Badiera domingensis* (Jacq.) DC. is correct, although he has distributed Santo Domingo specimens under the name *B. domingensis*.

1*a*. **Badiera portoricensis** sp. nov.

A tree up to 6 m. high, the trunk sometimes 1.5 m. in diameter, the slender branches ascending, the young twigs appressed-pubescent. Leaves subcoriaceous, obovate, 3 cm. long or less, 7–15 mm. wide, bright green and shining above, paler and rather dull green beneath, both surfaces with short, scattered hairs when young, becoming glabrate above, the midvein slightly impressed above, rather prominent beneath, the lateral veins few, distant, obscure, the apex rounded or obtuse, the base narrowed or cuneate, the pubescent petioles 1–2.5 mm. long; inflorescence few–several-flowered, 4–6 mm. long; bracts ovate or ovate-lanceolate, acute, pubescent, 0.5 mm. long; pedicels appressed-pubescent, 1.5–2.5 mm. long; sepals broadly ovate, obtuse, ciliolate, the larger about 1 mm. long; petals white; keel appressed-pubescent, 2 mm. long, narrowed below; fruit about 6 mm. wide, about 5 mm. high, finely pubescent, narrowly margined, notched at the apex, subtruncate at the base, its stipe about 0.6 mm. long.

Rocky slopes and hillsides, western Porto Rico, especially on serpentine, from sea-level to 700 m. altitude. Type collected at Guanajibo, near Mayaguez (*Britton, Cowell & Brown 4349*). Recorded by Bello from my type locality as *B. domingensis* DC. [*Polygala domingensis* Jacq.; *B. Penaea* (L.) DC.] of Hispaniola, to which species it is nearest related, but which differs in pilose-pubescent twigs, rather densely pubescent leaves, and much more pubescent, shorter-pedicelled flowers.

2. BADIERA VIRGATA Britton

The specimen referred to by me under *B. oblongata* Britton (*Britton & Wilson 6066*) from Santa Clara, Cuba, is now, in the light of additional material, put with *B. virgata*, as a broad-leaved race.

4. BADIERA DIVERSIFOLIA (L.) DC.

This, the only Jamaican species of the genus, forms a tree up to 6 m. high, as at St. Ann's Bay (*Britton 2498*).

5. BADIERA CUBENSIS Britton

In the original description of this species (Bull. Torrey Club **37**: 362), I included too many citations of specimens. C. Wright's Cuban *1913* consists, apparently, of three species; it is to the specimen with abruptly acuminate leaves cuneate-narrowed at the base, 4–6 cm. long, that the name should be restricted. As shown by specimens from Bahia Honda, Pinar del Rio (*P. Wilson 9429*) the leaves vary to obovate. The fruit is glabrous when mature, its slender stipe 2 mm. long.

5*a*. BADIERA FUERTESII Urban, Symb. Ant. 7: 244. 1912

A tree of the mountains of Santo Domingo, with glabrous leaves, strongly reticulate-veined on the upper surface.

6. BADIERA MONTANA Britton

Described from fruiting specimens collected in the Trinidad Mountains, Santa Clara, Cuba. Flowering specimens with apparently the same foliage and pubescence come from limestone hills in the vicinity of Sumidero, Pinar del Rio (*Shafer 13819*), but flowers from the Trinidad Mountain tree are needed to make the identity wholly satisfactory.

8. **Badiera propinqua** sp. nov.

Twigs slender, densely appressed-pubescent. Leaves ovate to ovate-elliptic, 2–4.5 cm. long, 8–25 mm. wide, bluntly acute or obtuse and emarginate at the apex, narrowed or obtuse at the base, sparingly short-pubescent on both sides or becoming glabrous, the midvein impressed above, prominent beneath, the slender lateral veins 6 to 8 on each side of the midvein, the appressed-pubescent petioles 1.5–3 mm. long; inflorescence few-flowered,

4–5 mm. long; bracts ovate, densely pubescent, scarcely 0.5 mm. long; pedicels slender, appressed-pubescent, 1.5–2.5 mm. long; sepals suborbicular, rounded, pubescent, the larger about 1.3 mm. long; petals white; keel pubescent on the sides, about 2.5 mm. long; fruit (from *Wright 1913, in part*) 10 mm. wide, 7 mm. long, deeply notched, scarcely margined, glabrous, decurrent on its stipe, which is about 2 mm. long.

Cuba. Type collected between Los Palacios and San Juan de Zayas, Pinar del Rio (*Shafer 11818*). The description is drawn to include the part of *Wright 1913*, and *Wright 3496*, previously referred by me to *B. cubensis*. The part of *Wright 115*, included by me in the original description of *B. cubensis*, is perhaps referable here also.

9. **Badiera punctata** sp. nov.

A shrub about 1 m. high, with slender, ascending, or nearly erect branches, the twigs densely appressed-pubescent with short hairs. Leaves ovate to ovate-elliptic, firm in texture, 1.5–2.5 cm. long, 12 mm. wide or less, obtuse or emarginate at the apex, obtuse at the base, the midvein impressed above, prominent beneath, the lateral veins 3 or 4 on each side, the upper surface strongly punctate, shining and glabrous or nearly so, the under surface dull, the petioles about 1.5 mm. long; inflorescence few-flowered; bracts scarcely 0.5 mm. long; fruiting pedicels slender, nearly glabrous, 2–2.5 mm. long; sepals ovate, obtuse, ciliate, about 1 mm. long; fruit (not quite mature) "green and red," 7 mm. wide, about as long as wide, shallowly notched at the apex, obliquely subtruncate at the base, narrowly margined, slightly pubescent, its stipe 1–1.5 mm. long.

Near a stream, Arroyo del Medio above the falls, Oriente, Cuba (*Shafer 3644*). The leaves droop at night, a phenomenon also observed in *B. virgata*.

10. **Badiera heterophylla** sp. nov.

An upright shrub 6 dm. high, the twigs short-pubescent with somewhat spreading hairs. Leaves of two quite different forms, (1) narrowly ovate, 3–4 cm. long, 12–18 mm. wide, bluntly acute at the apex, (2) elliptic, 2–2.5 cm. long, 12–14 mm. wide, rounded or obtuse at the apex; both forms emarginate at the apex, narrowed or obtuse at the base, sparingly short-pubescent and dull on both sides, the midvein impressed above, prominent beneath, the slender lateral veins only 2 or 3 on each side of the midvein,

the appressed-pubescent petioles about 2 mm. long; inflorescence about 5 mm. long; bracts about 0.5 mm. long; pedicels pubescent, 2 mm. long or less; sepals rounded, pubescent, the larger about 1 mm. long; "flowers yellow"; petals slightly pubescent in the bud; fruit 7–8 mm. wide, about 5 mm. high, margined, rather deeply notched, sparingly pubescent when young, glabrous when mature, slightly decurrent on its stipe which is about 1.5 mm. long.

Deciduous woods, Sierra Nipe, near Woodfred, Oriente, at 450–550 m. altitude (*Shafer 3070*).

40. THE GENUS TRICERA Sw. IN CUBA

1. Styles coherent, at least at the base.
   - Leaves oblong to oblong-lanceolate, 2–3 cm. wide; styles coherent below. — 1. *T. Muelleriana.*
   - Leaves broadly ovate to ovate-lanceolate, 5 cm. wide or less; styles coherent nearly throughout. — 2. *T. marginalis.*
2. Styles separate and distinct.
   - * Leaves 4–10 cm. long.
     - Venation of the leaves manifest.
       - Leaves broadly ovate, subcordate. — 3. *T. cubana.*
       - Leaves lanceolate to elliptic or obovate, narrowed at the base.
         - Capsule globose-ellipsoid. — 4. *T. acuminata.*
         - Capsule ovoid, acute. — 5. *T. brevipes.*
     - Venation of the leaves obsolete or indistinct.
       - Petioles very stout, 10 mm. long or less; leaves very thick. — 6. *T. crassifolia.*
       - Petioles slender, 2–6 mm. long; leaves firm, but not very thick.
         - Twigs yellow. — 7. *T. flaviramea.*
         - Twigs green.
           - Capsule-lobes semiovate. — 8. *T. retusa.*
           - Capsule-lobes linear-spatulate. — 9. *T. gonoclada.*
   - ** Leaves 1–3.5 cm. long.
     - Leaves suborbicular to obovate or elliptic, not more than twice as long as wide.
       - Inflorescence and capsule glabrous. — 10. *T. rotundifolia.*
       - Inflorescence and capsule pubescent. — 11. *T. Shaferi.*
     - Leaves oblong to linear-oblanceolate, 2–5 times as long as wide.
       - Leaves oblong, 2–3 times as long as wide.
         - Leaves densely imbricated, less than 1 cm. long, the internodes very short. — 12. *T. vaccinoides.*
         - Leaves not densely imbricated, 1.5–3.5 cm. long.
           - Staminate flowers sessile or very nearly so. — 13. *T. glomerata.*
           - Staminate flowers manifestly pedicelled.
             - Leaves 2–3.5 cm. long, the lateral venation obsolete. — 14. *T. bahamensis.*

Leaves 1–1.5 cm. long, the lateral venation wholly obscure. 15. *T. microphylla.*

Leaves linear-oblanceolate or linear-oblong, 4–5 times as long as wide.

Capsule glabrous. 16. *T. Leoni.*

Capsule pubescent.

Leaves strongly revolute-margined, abruptly mucronate. 17. *T. revoluta.*

Leaves scarcely revolute-margined, acute or obtuse. 18. *T. foliosa.*

1. **Tricera Muelleriana** (Urban)

Buxus Muelleriana Urban, Symb. Ant. 5: 400. 1908.

TYPE LOCALITY: Cuba.

DISTRIBUTION: Known only from the type specimens (*C. Wright 1920*).

Referred by Grisebach to *Tricera laevigata* Sw., of Jamaica, and by Mueller to *Buxus subcolumnaris* Muell. Arg. = **Tricera subcolumnaris** (Muell. Arg.) Britton, of Martinique.

2. **Tricera marginalis** sp. nov.

A glabrous shrub about 3 m. high. Leaves broadly ovate to ovate-lanceolate, subcoriaceous, 4–8 cm. long, 2–5 cm. wide, reticulate-veined on both sides, with 2 distinct veins 1.5–3 mm. from the margins, the midvein impressed above, prominent beneath, the apex acute, the base obtuse or subtruncate, the rather slender petioles 1 cm. long or less; cymes several-flowered, longer than the petioles, glabrous; bracts ovate-lanceolate, acute, 1.5 mm. long; pedicels of the staminate flowers about 4 mm. long, the white calyx about 3 mm. long, its segments oblong, obtuse; stamens about as long as the calyx, the filaments about twice as long as the anthers; ovary ovoid; united styles somewhat longer than the ovary; stigmas recurved, about one-third as long as the styles.

Alluvial valley of Rio Yamaniguey, Oriente (*Shafer 4226*).

3. TRICERA CUBANA A. Rich. in Sagra, Hist. Cub. 11: 217. *pl. 71.* 1845

Buxus cubana Baill. Mon. Bux. 71. 1859.

TYPE LOCALITY: Monte Libau, Oriente.

ILLUSTRATION: A. Rich. *loc. cit.*

DISTRIBUTION: Known only from the type locality.

4. **Tricera acuminata** Griseb. Nachr. Gesell. Wiss. Goetting. **1865**: 162. 1865

Buxus acuminata Muell. Arg. in DC. Prodr. **16**[1]: 15. 1869.

TYPE LOCALITY: Cuba.

DISTRIBUTION: Known only from the type specimens (*C. Wright 1919*, in part).

5. **Tricera brevipes** (Muell. Arg.)

Buxus citrifolia brevipes Muell. Arg. in DC. Prodr. **16**[1]: 15. 1869.
Buxus brevipes Urban, Symb. Ant. **5**: 400. 1908.

TYPE LOCALITY: Cuba (*C. Wright 1919*, in part).

DISTRIBUTION: the label with *Wright 1919* in the herbarium of the New York Botanical Garden gives the locality as San Diego de Tapis; the following specimens appear to agree with it: upper valley of the Rio Navas, Oriente (*Shafer 4402*); Rio San Miguel below Mal Paso, Pinar del Rio (*P. Wilson 9309*).

Referred by Grisebach to *T. fasciculata* Griseb., of Jamaica. I am not confident that the species is distinct from *T. acuminata*.

6. **Tricera** (?) **crassifolia** sp. nov.

A glabrous shrub about 3 m. high, the twigs stout. Leaves elliptic-obovate, 6–10 cm. long, 2.5–4 cm. wide, very thick, obtuse or emarginate and mucronulate at the apex, narrowed at the base, the midvein impressed above, prominent beneath, the lateral venation faint and obscure, the stout petioles about 1 cm. long; young inflorescence axillary, about as long as the petioles, both staminate and pistillate flowers apparently sessile, the staminate about 2 mm. long.

Between Camp Toa and Camp La Barga, 400–450 m. alt., mountains of northern Oriente (*Shafer 4163*).

7. **Tricera flaviramea** sp. nov.

A glabrous shrub, 1 m. high, the young twigs and leaves yellowish green, the branches slender, somewhat ridged. Leaves elliptic or elliptic-obovate, coriaceous, revolute-margined, 3–5 cm. long, 1–2 cm. wide, rounded and minutely apiculate or emarginate at the apex, narrowed at the base, the midvein impressed above, rather prominent beneath, the lateral venation obsolete, or faintly discernible on the upper surface, the petioles 1.5–3 mm. long; inflorescence glabrous, about 1 cm. long; bracts ovate, acute, 1.5

mm. long; young staminate flowers about 2 mm. long, on pedicels about as long; capsule ovoid, obtuse, glabrous, 7–8 mm. long, 5–6 mm. thick, the persistent styles somewhat recurved, linear, 5 mm. long, separated from each other about 1 mm. at the base.

Palm-barren, Santa Clara City, Santa Clara (*Britton & Cowell 13324*, type; *Britton & Wilson 6211*).

8. TRICERA RETUSA Griseb. Nachr. Ges. Wiss. Goetting. **1865**: 163. 1865

Buxus retusa Muell. Arg. in DC. Prodr. **16**[1]: 17. 1869.

TYPE LOCALITY: Monte Verde, Oriente.

DISTRIBUTION: Mountains of northern Oriente.

9. TRICERA GONOCLADA C. Wright; Griseb. Cat. Pl. Cub. 282. 1866

Buxus gonoclada Muell. Arg. in DC. Prodr. **16**[1]: 16. 1869.

TYPE LOCALITY: Savanna near Guamacaro, western Cuba.

DISTRIBUTION: Known only from the type locality.

10. **Tricera rotundifolia** sp. nov.

A glabrous shrub, 6 dm. high, much branched, the internodes mostly shorter than the leaves. Leaves suborbicular to obovate, coriaceous, 2 cm. long or less, rounded and mucronulate or slightly emarginate at the apex, narrowed at the base, the margins thickened and somewhat revolute, the midvein rather prominent beneath, the lateral venation obsolete, the petioles 1.5–2 mm. long; inflorescence glabrous, few-flowered, in the uppermost axils; pedicels of the staminate flowers about 3 mm. long; bracts ovate, acute, 1 mm. long; staminate flowers 1.5 mm. long, their segments oblong-lanceolate, acute; capsule ovoid, about 6 mm. long, glabrous, the persistent styles contiguous, about 2 mm. long.

Between Camp La Barga and Camp San Benito, about 1,000 m. alt., northern Oriente (*Shafer 4114*).

11. **Tricera Shaferi** sp. nov.

A much-branched shrub up to 3 m. high, the twigs slender, glabrous, the internodes shorter than the leaves. Leaves obovate to elliptic, coriaceous, 1.5–3.5 cm. long, rounded or retuse at the apex and minutely mucronulate, narrowed or obtuse at the base, the midvein impressed above, prominent beneath, the lateral venation wholly obscure, the upper surface shining, dark green,

the under surface dull and pale, the petioles 1–3 mm. long; inflorescence axillary, puberulent, short-stalked, much shorter than the leaves; bracts ovate, acute, about 0.5 mm. long; pedicels of the staminate flowers rather stout, 2–3 mm. long; staminate flowers about 1.5 mm. long; capsule subglobose, densely puberulent, about 4 mm. in diameter, the separated persistent styles about 2 mm. long.

Wet mountains of northern Oriente. Type collected between Camp Toa and Camp La Barga, 400–450 m. alt. (*Shafer 4167*).

12. **Tricera vaccinioides** sp. nov.

A low, glabrous, much-branched shrub, 3–6 dm. high, the branches stout, the twigs erect-ascending, densely leafy, the internodes 3–6 mm. long. Leaves oblong to oblong-obovate, 5–8 mm. long, about twice as long as wide, coriaceous, faintly 3-veined, the secondary venation almost wholly obscure, the apex acute and mucronate, the base narrowed, the stout petioles scarcely 1 mm. long; inflorescence terminal, glabrous, few–several-flowered; pedicels of the staminate flowers rather stout, rigid, about 2 mm. long; bracts lanceolate; staminate flowers about 1 mm. long; capsule globose-ovoid, glabrous, dull, about 6 mm. long, about three times as long as the persistent styles.

Stony pass, between Camp La Barga and Camp San Benito, mountains of northern Oriente, Cuba, about 1000 m. alt. (*Shafer 4122*).

13. TRICERA GLOMERATA Griseb. Mem. Am. Acad. II. 8: 157. 1860

Buxus glomerata Muell. Arg. in DC. Prodr. 16[1]: 17. 1869.

TYPE LOCALITY: Cuba.

DISTRIBUTION: Dry rocky hillsides, Oriente; Santa Clara. This is a shrub up to 3 m. high, abundant near the mouth of Cienfuegos Bay; I am indebted to Professor Fernald for a comparison of a specimen collected there, at Castillo de Jagua (*Britton, Wilson & Earle 4597*), with the specimen of C. Wright in the Gray Herbarium; he pronounced it "a perfect match."

14. TRICERA BAHAMENSIS (Baker) Britton, Bull. N. Y. Bot. Gard. 4: 139. 1906

Buxus bahamensis Baker in Hook. Ic. Pl. *pl. 1806.* 1889.

TYPE LOCALITY: Long Cay, Bahamas.

DISTRIBUTION: Cayo Romano, Camaguey:—Bahamas; Jamaica. Closely related to **Tricera Vahlii** (Baill.) Britton [*Buxus Vahlii* Baill.] of Porto Rico and St. Croix.

15. TRICERA MICROPHYLLA Griseb. Nachr. Ges. Wiss. Goetting. **1865**: 163. 1865

Buxus Wrightii Muell. Arg. in DC. Prodr. **61**[1]: 17. 1869.

TYPE LOCALITY: Western Cuba.

DISTRIBUTION: Known only from the type specimens collected by Wright.

16. **Tricera Leoni** sp. nov.

A shrub, or small tree, up to 4 m. high, glabrous throughout, the slender twigs densely leafy. Leaves linear to linear-oblong, coriaceous, shining, 2 cm. long or less, 2–4 mm. wide, spinulose-acute at the apex, narrowed at the base, the midvein faintly distinguishable above, rather prominent beneath, the lateral venation wholly obscure, the petioles 1–1.5 mm. long; inflorescence terminal, short-stalked; bracts ovate, acute, about 1 mm. long; pedicels of the staminate flowers 1.5–2 mm. long; staminate perianth-segments oblong-lanceolate, acute, 2–2.5 mm. long, filaments a little longer than the anthers; capsule globose-oblong; glabrous, 3 mm. long, the separated, persistent styles 2 mm. long.

Hill north of Monte Catalina, northeast of San Diego de los Banos, Pinar del Rio (*Brothers Leon & Charles 4874*, type); barren specimens from the southern slope of Monte Cajálbana, Pinar del Rio (*Brothers Leon & Charles 4943*), with narrower leaves than the type, are provisionally referred to the same species.

17. **Tricera revoluta** sp. nov.

A much-branched shrub, 3–10 dm. high, the twigs densely leafy, the internodes only 1–2 mm. long. Leaves linear-oblanceolate, coriaceous, 12–20 mm. long, 3–5 mm. wide, strongly revolute-margined, sharply cuspidate-mucronate at the apex, attenuate at the base, the midvein elevated beneath, the venation otherwise wholly obscure, the petioles about 2 mm. long; inflorescence few-flowered in the upper axils, pubescent; staminate flowers nearly 2 mm. long, and nearly as long as their stout pedicels; capsule subglobose, 5–6 mm. long, pubescent, shorter than the persistent, separated styles.

Dry, rocky situations, serpentine hills near mouth of Rio Yamaniguey, Oriente (*Shafer 4247*, type); between Camp La

Barga and Camp San Benito, about 1,000 m. alt., Oriente (*Shafer 4472*).

18. **Tricera foliosa** sp. nov.

A low, much-branched shrub, the slender twigs densely leafy. Leaves linear-oblanceolate, subcoriaceous, glabrous, 10–15 mm. long, 2 mm. wide or less, obtuse and often minutely mucronulate at the apex, long-attenuate to the base, the midvein impressed above, slightly elevated and channeled beneath, the lateral venation wholly obscure, the margins slightly or scarcely revolute, the petioles 1–2 mm. long; inflorescence axillary, shorter than the leaves; staminate flowers white, about 1.5 mm. long, as long or longer than their pubescent petioles; bracts lanceolate, about 1 mm. long; capsule subglobose, densely and finely pubescent, about 3 mm. in diameter, the separated persistent styles about 2 mm. long.

Among rocks near water, Camp La Gloria, south of Sierra Moa, Oriente (*Shafer 8256*, type); on rocks, vicinity of Camp San Benito, Oriente (*Shafer 4073*).

41. THE GENUS PLUMIERA L. IN CUBA

Leaves narrowly linear, 1.7 mm. wide or less. 1. *P. filifolia.*
Leaves oblong to elliptic-oblanceolate or obovate, 1–8 cm. wide.
  Leaves densely lanate or pubescent beneath.
    Corolla-lobes narrowly obovate. 2. *P. sericifolia.*
    Corolla-lobes broadly elliptic-obovate. 3. *P. lanata.*
  Leaves glabrous, or sparingly pubescent beneath.
    Petioles short, 1 cm. long or less.
      Leaves obovate or oblanceolate, the lateral venation obscure. 4. *P. clusioides.*
      Leaves narrowly oblong, the lateral venation prominent. 5. *P. nipensis.*
    Petioles slender, mostly 2–4 cm. long.
      Leaves glabrous beneath, their margins not involute.
        Corolla-lobes 2.5–3.5 cm. long, 1–1.5 cm. wide; venation widely spreading. 6. *P. emarginata.*
        Corolla-lobes 1.5–2.5 cm. long.
          Venation of the leaves ascending, not prominent beneath; corolla-lobes obovate. 7. *P. obtusa.*
          Venation of the leaves widely spreading, prominent beneath; corolla-lobes oblong-oblanceolate. 8. *P. venosa.*
      Leaves pubescent on the veins beneath, their margins involute. 9. *P. trinitensis.*

1. PLUMIERA FILIFOLIA Griseb. Mem. Am. Acad. II. 8: 519. 1862

River cliffs, foothills of the Sierra Maestra, Nouvelle Sophie and Ensenada de Mora, Oriente. Endemic.

2. PLUMIERA SERICIFOLIA C. Wright; Griseb. Cat. Pl. Cub. 171. 1866

P. emarginata sericifolia Maza, Anales Soc. Esp. Hist. Nat. **23**: 273. 1894.

Coastal thickets, Oriente; Matanzas; Havana; Pinar del Rio: —Inagua.

Perhaps, as suggested by Professor Gomez de la Maza, a pubescent race of *P. emarginata* Griseb., which has a similar distribution in western Cuba, although I have not seen the two growing in close proximity.

3. **Plumiera lanata** sp. nov.

A shrub or small tree up to 3.3 m. high. Leaves broadly elliptic to elliptic-obovate, firm in texture, 10–18 cm. long, 5–9 cm. wide, rounded, emarginate or subtruncate at the apex, narrowed or subtruncate at the base, dark green and glabrous above, densely white-lanate beneath, the midvein channeled above, prominent beneath, the lateral veins widely spreading, averaging 6 or 7 mm. apart, united close to the margin, the stout, somewhat pubescent petioles 1–2.5 cm. long; peduncle 3–11 cm. long, glabrous; cymes many-flowered, dense; pedicels 10 mm. long or less, glabrous or pubescent; calyx subtruncate, 2–3 mm. long; corolla-tube about 1.5 cm. long; corolla-lobes broadly elliptic-obovate, white, rounded, 1.5–2.5 cm. long, 1.2–2 cm. wide; follicles 8–10 cm. long, about 1 cm. thick, short-pointed.

Coastal rocks, vicinity of Baracoa, Oriente (*Underwood & Earle 1442*).

4. PLUMIERA CLUSIOIDES Griseb. Cat. Pl. Cub. 171. 1866

? *P. obtusa parvifolia* Griseb. Mem. Am. Acad. II. 8: 519. 1862.

? *P. clusioides parvifolia* Maza, Anales Soc. Esp. Hist. Nat. **23**: 273. 1894.

Rocky hillsides and palm-barrens, Oriente; Camaguey; Santa Clara, Havana. Endemic.

Fruiting specimens collected by Dr. Shafer in the gorge of the

Rio Yamuri, Oriente (*7800*), tentatively referred to this species, have spatulate leaves 12 cm. long.

5. **Plumiera nipensis** sp. nov.

A slender tree, up to about 6 m. in height. Leaves narrowly oblong, 9–12 cm. long, 1.5–2.3 cm. wide, obtuse at the apex, narrowed at the base, glabrous on both sides, shining above, dull beneath, the midvein channeled above, prominent beneath, the lateral venation widely spreading, impressed, but distinct, above, the rather slender petioles 1 cm. long or less; peduncle stout, 6 cm. long; follicles 13–15 cm. long, about 2 cm. thick, acutish; seeds 10 mm. long, 6–7 mm. wide, the wing about 15 mm. long, 8–9 mm. wide.

Rocky thicket, between Piedra Gorda and Woodfred, Sierra Nipe, Oriente, at 500 m. alt. (*Shafer 3089*). Perhaps the same as *P. obtusa laevis* Griseb. (Mem. Am. Acad. II. 8: 519) from Monte Verde, Oriente.

6. PLUMIERA EMARGINATA Griseb. Cat. Pl. Cub. 171. 1866

Rocky cliffs and hillsides, Matanzas; Pinar del Rio; Isle of Pines. Endemic.

7. PLUMIERA OBTUSA L. Sp. Pl. 210. 1753

Coastal hills, keys and thickets, Oriente; Camaguey; Santa Clara:—Bahamas; Hispaniola; Mona. Attributed to Jamaica, but some specimens which have been so referred represent a distinct species.*

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* **Plumiera confusa** sp. nov.

A tree, up to 6 m. high, little branched, glabrous throughout. Leaves narrowly elliptic or oblong, shining, 1–3 dm. long, 7 cm. wide or less, obtuse, emarginate or acute at the apex, narrowed at the base, the midvein channeled above, prominent beneath, the lateral venation widely spreading, the stout petioles 4–8 cm. long; peduncles stout, 7–15 cm. long; cymes large, many-flowered; pedicels rather stout, thickened upward, 9–12 mm. long; calyx nearly truncate, about 3 mm. long; corolla white with a pale yellow eye, its tube 12–15 mm. long, its lobes broadly oblong, rounded, 2.5–3 cm. long, about 1 cm. wide; follicles 8–12 cm. long, 10–12 mm. thick.

Rocky situations, southern side of Jamaica. Type collected on Great Goat Island (*Harris 9309*);

The species more resembles *P. emarginata* than *P. obtusa*. I am unable to determine, from the material available at this time, whether *P. obtusa* occurs on Jamaica or not. Other specimens referable to *P. confusa* are: Healthshire Hills near Salt Island (*Britton 3061*); base of Healthshire Hills near Salt Ponds (*Britton 3036*); Great Goat Island (*Harris 10168; Britton 1874*).

The *Plumiera* of Pedro Bluff, a locality about thirty miles west of Great Goat Island, but still within the xerophytic region, may be *P. obtusa*, but the specimen

8. **Plumiera venosa** sp. nov.

A tree up to 6 m. high, glabrous throughout. Leaves oblong-oblanceolate to narrowly obovate, 7–15 cm. long, 3 cm. wide or less, obtuse or emarginate at the apex, narrowed or cuneate at the base, the midvein impressed above, prominent beneath, the lateral veins numerous, widely spreading, united near the margin, 2–3 mm. apart, prominent beneath; petioles slender, 2–3 cm. long; cymes several–many-flowered; peduncles 6–10 cm. long; pedicels 8–15 mm. long, upwardly somewhat thickened; calyx about 3 mm. long, its teeth very broad and short; corolla-tube about 1.5 cm. long; corolla-lobes narrowly oblong-oblanceolate, 2–2.7 cm. long; follicles 10–15 cm. long, about 12 mm. thick; seed nearly 1 cm. long, its wing about 1.5 cm. long.

Coastal cliffs and hillsides near the coast, southern Oriente. Type collected in the basin of Rio Guama, Sevilla Estate near Santiago (*Taylor 93*).

Shoots from cut stumps bear nearly linear leaves up to 2 dm. long, 10–15 mm. wide, as seen by me in a coastal thicket near the mouth of Santiago Harbor (*Britton & Cowell 12632*).

9. **Plumiera trinitensis** sp. nov.

A tree 5 m. high. Leaves oblong to oblong-oblanceolate, 11 cm. long or less, 1.5–3.5 cm. wide, obtuse or emarginate at the apex, gradually narrowed to the base, glabrous above, pubescent on the veins beneath, the midvein broad, channeled above, prominent beneath, the lateral veins rather widely spreading, 2–4 mm. apart, united near the revolute margins; petioles 1.5–2.5 cm. long; follicle slightly curved, pointed, 18 cm. long, about 1.5 cm. thick.

Dry hillside, La Vigia, Trinidad, Santa Clara (*Britton & Wilson 5514*). Similar to *P. jamaicensis* Britton, which is a glabrous species up to 10 m. high, with broader leaves.

(*Harris 9996*) is not complete. In 1895, E. Campbell collected a *Plumiera* at Constant Spring (*5973*), which may be *P. obtusa*.

Growing with *P. confusa* on Great Goat Island there is a *Plumiera* which has leaves over 3 dm. long, narrowly oblong to linear-oblong, some of them not more than 3 cm. wide, and all long-acuminate at the apex (*Britton 1870*). It was not in flower at the time of my visit, March 4, 1908, but I obtained its fruit, which is much like that of *P. confusa*, and its leaf-venation resembles that of *P. confusa* also; it may be that *P. confusa* is sufficiently heterophyllous to have these narrow, elongated, long-pointed leaves.

42. THE GENUS GUETTARDA L. IN CUBA

A. Leaves minute, nearly sessile, 6 mm. long or less. 1. *G. Echinodendron.*

B. Leaves larger, 1.5 cm. long or more.

a. Leaves spinulose-tipped.

Leaves ovate to elliptic, strongly reticulate-veined beneath. 2. *G. Coxiana.*

Leaves oblong, scarcely reticulate-veined beneath. 3. *G. cueroensis.*

b. Leaves not spinulose-tipped.

* Leaves small, 3.5 cm. long or less; flowers axillary, mostly solitary.

Leaves densely silvery-silky beneath. 4. *G. rigida.*

Leaves glabrous or somewhat pubescent beneath.

Flowers sessile or nearly so; leaves ovate or oblong.

Venation inconspicuous on upper leaf-surfaces.

Corolla nearly 2 cm. long; calyx spathaceous. 5. *G. camagueyensis.*

Corolla 1–1.5 cm. long.

Calyx spathaceous; corolla-tube little longer than the limb. 6. *G. clarensis.*

Calyx truncate or oblique; corolla-tube 3–4 times as long as the limb. 7. *G. undulata.*

Venation prominent on upper leaf-surfaces. 8. *G. xanthocarpa.*

Peduncles nearly as long as the fruits; leaves obovate. 9. *G. sciaphila.*

** Leaves larger, 3.5–15 cm. long.

† Inflorescence capitate or clustered or flowers solitary at the ends of twigs, or some flowers also peduncled in the upper axils.

Inflorescence capitate-clustered.

Leaves densely pubescent or puberulent beneath.

Leaves densely puberulent beneath. 10. *G. densiflora.*

Leaves villous beneath, at least on the veins.

Fruit 2–3 cm. in diameter. 11. *G. macrocarpa.*

Fruit 6–15 mm. in diameter.

Fruit 10–15 mm. in diameter, densely puberulent; leaves densely villous beneath. 12. *G. ferruginea.*

Fruit about 6 mm. in diameter, villous; leaves villous on the veins beneath. 13. *G. lanuginosa.*

Leaves pubescent only on the veins beneath. 14. *G. crassipes.*

Flowers solitary or sometimes 2. 15. *G. zygophlebia.*

†† Inflorescence axillary, peduncled.

‡ Inflorescence 1–several-flowered.

Leaves cordate at the base; corolla 3–4 cm. long. 16. *G. calyptrata.*
Leaves not cordate; corolla much smaller.
Leaves glabrous on both sides, coriaceous.
Peduncles short, 3–15 mm. long, 1–2-flowered. 17. *G. monocarpa.*
Peduncles long, 3–8 cm. long, few–several-flowered. 18. *G. Valenzuelana.*
Leaves thin, pubescent beneath, at least on the veins.
Leaves appressed-silky beneath, long-acuminate at the apex. 19. *G. calcicola.*
Pubescence not silky; leaves obtuse to acute or short-acuminate.
Fruit oblong. 20. *G. Lindeniana.*
Fruit subglobose.
Leaves prominently reticulate-veined beneath.
Leaves setulose above. 21. *G. brevinodis.*
Leaves not setulose above. 22. *G. inaequipes.*
Leaves not prominently reticulate-veined beneath. 23. *G. elliptica.*
‡‡ Inflorescence several–many-flowered.
Leaves thick, scabrous above. 24. *G. scabra.*
Leaves thin, smooth above. 25. *G. Combsii.*
C. Species known to me only from the description. 26. *G. retusa.*

1. GUETTARDA ECHINODENDRON C. Wright; Sauvalle, Anales Acad. Habana **6**: 124. 1869

Stenostomum microphyllum Griseb. Cat. Pl. Cub. 133. 1866. Not *Guettarda microphylla* Bartl.

TYPE LOCALITY: Near San Marcos, western Cuba.

DISTRIBUTION: Known only from the type locality.

2. **Guettarda Coxiana** sp. nov.

A shrub, 2.5 m. high, with short, slender, densely pubescent twigs, the leaf-scars long-persistent. Stipules ovate, acuminate, 2–3 mm. long; leaves ovate or ovate-elliptic, 2 cm. long or less, coriaceous, rigid, the apex acute and spinulose-tipped, the base obtuse, the upper surface smooth, with indistinct venation, the under surface very prominently reticulate-veined and densely pubescent, the stout pubescent petiole 1–2 mm. long; peduncles axillary, 1-flowered or 2-flowered, pubescent, 2.5–3 mm. long; bractlets subulate, 1 mm. long; calyx obconic, truncate, densely puberulent, 2 mm. long; corolla yellowish, densely puberulent,

about 3 mm. long; young fruit narrowly obovoid, puberulent, faintly ribbed, 4 mm. long, the persistent calyx-limb about 1.5 mm. long.

Rocky coastal hill, Daiquiri, Oriente (*Britton & Cowell 12685*). Named in memory of the late Jennings S. Cox, who, as manager of the Spanish American Iron Company, greatly facilitated scientific investigation in eastern Cuba.

3. **Guettarda cueroensis** sp. nov.

A tree 5 m. high, with slender branches, the young twigs appressed-pubescent. Stipules ovate, acute, pubescent, 2–3 mm. long; leaves clustered at the ends of short spurs, oblong to oblong-lanceolate, 3 cm. long or less, 6–12 mm. wide, coriaceous, acute and spinulose-tipped at the apex, obtuse or subtruncate at the base, loosely reticulate-veined on both sides, glabrous and shining above, puberulent beneath, the finely pubescent petiole 1.5–2 mm. long; flowers solitary in the axils; peduncles pubescent, stout, 2 mm. long or less; calyx subspathaceous, densely pubescent, about 3 mm. long; corolla whitish, densely pubescent, about 8 mm. long, the slender tube about 3 times as long as the limb; fruit subglobose, or globose-obovoid, densely puberulent, 8–10 mm. in diameter.

Hill, 150 m. alt., El Cuero, Oriente (*Britton & Cowell 12733*).

4. GUETTARDA RIGIDA A. Rich. in Sagra, Hist. Cub. **11**: 20. 1850

G. holocarpa Wright; Sauvalle, Anales Acad. Habana **6**: 123. 1869.

TYPE LOCALITY: Cuba.

DISTRIBUTION: Thickets and hillsides, near Regla and Guanabacoa, Havana. Endemic.

I have not seen an authentic specimen of *G. rigida*, and am referring *G. holocarpa* to it from the description. It is the only small-leaved species with silky pubescence on the under side of the leaf known to me from Cuba.

5. **Guettarda camagueyensis** sp. nov.

A shrub, 1 m. high, with terete, widely spreading branches, the young twigs brownish-pubescent with appressed hairs. Stipules pubescent, ovate, sharply acute, 3–4 mm. long; leaves ovate, rigid, coriaceous, 1.5–2.5 cm. long, 10–18 mm. wide, rounded and obtuse at the apex, cordate or subcordate at the base, ciliate, at

least when young, smooth, glabrous and inconspicuously veined above, densely reticulate-veined and pubescent beneath the stout petioles about 1 mm. long; flowers solitary and nearly sessile in the axils; calyx spathaceous, appressed-pubescent, 5–6 mm. long, its lobes acute; corolla white, appressed-pubescent with long hairs, about 1.7 cm. long, the limb about one-third as long as the slender tube; fruit nearly sessile, globose, densely brownish-puberulent, about 12 mm. in diameter.

Palm-barren between Camaguey and Santayana (*Britton 2409*, type); Corojo, Camaguey (*Brother Leon 3725*).

6. **Guettarda clarensis** sp. nov.

A shrub with terete branches, the young twigs densely pubescent with long brown, somewhat spreading hairs. Stipules ovate, acute, pubescent, 5 mm. long, deciduous; leaves ovate-oblong, 2.5 cm. long or less, 8–14 mm. wide, obtuse at the apex, subcordate at the base, loosely pubescent with spreading brown hairs and inconspicuously veined above, prominently and densely reticulate-veined and pubescent beneath, the elevated midrib bearing long brown hairs; petioles stout, villous, scarcely 1 mm. long; flowers sessile and solitary in the axils; calyx spathaceous, appressed-pubescent, about 5 mm. long, its broad lobes acutish; corolla about 1 cm. long, its stout tube densely clothed with long appressed, white hairs.

Palm-barren, city of Santa Clara (*Britton & Wilson 6176*).

7. GUETTARDA UNDULATA Griseb. Cat. Pl. Cub. 131. 1866

TYPE LOCALITY: Rocky situations near Matanzas.

DISTRIBUTION: Known only from the type locality [near Punta Brava].

8. **Guettarda xanthocarpa** sp. nov.

A much-branched shrub, 1.5 m. high, the short, spur-like twigs terete, leaf-bearing at the ends. Stipules ovate, puberulent, about 1.5 mm. long; leaves oblong to oblong-lanceolate or elliptic, 2 cm. long or less, 6–12 mm. wide, coriaceous, glabrous or nearly so, acute or obtuse at the apex, subcordate at base, loosely and rather prominently reticulate-veined above, densely and finely reticulate-veined beneath, the puberulent, stout petiole 1–1.5 mm. long; fruit subglobose, yellow, densely puberulent, 6–8 mm. in diameter.

Coastal cliffs, near El Morro, Santiago Bay, Oriente (*Britton & Cowell 12538*, type); eastern Cuba (*Wright 2705*).

Grisebach referred Wright's *2705* to *G. undulata* Griseb.,

from which it differs in leaf-venation and pubescence; it also differs from our *12538* by shorter, broader and obtuse leaves, but is otherwise similar; when flowers are obtained it may, perhaps, be shown that they are distinct species.

9. GUETTARDA SCIAPHILA Urban, Symb. Ant. 7: 409. 1912

TYPE LOCALITY: Near the base of Loma Mensura, Oriente.

DISTRIBUTION: Known only from the type locality.

10. GUETTARDA DENSIFLORA Urban, Symb. Ant. 7: 407. 1912

TYPE LOCALITY: Pine-lands near Paso Estancia, Oriente.

DISTRIBUTION: Pine-lands, hillsides and savannas, northern Oriente.

Dr. Shafer's *3794*, collected on Loma Mensura, shows its fruit to be subglobose, puberulent, and about 12 mm. in diameter.

11. GUETTARDA MACROCARPA Griseb. Mem. Am. Acad. II. 8: 507. 1862

TYPE LOCALITY: Near Monte Verde, Oriente.

DISTRIBUTION: Known only from the type locality.

12. GUETTARDA FERRUGINEA Griseb. Cat. Pl. Cub. 131. 1866

G. calyptrata ferruginea C. Wright; Sauvalle, Anales Acad. Habana 6: 123. 1869.

TYPE LOCALITY: Pine-lands near Mayari, western Cuba.

DISTRIBUTION: Type locality, and in the mountains of northern Oriente. Endemic.

13. GUETTARDA LANUGINOSA Urban & Britton; Urban, Symb. Ant. 7: 407. 1912

TYPE LOCALITY: Cayo Romano, Camaguey.

DISTRIBUTION: Known only from the type locality.

14. **Guettarda crassipes** sp. nov.

A shrub 1–1.6 m. high, with stout twigs, the young ones densely appressed-pubescent. Stipules ovate, densely pubescent, about 7 mm. long, deciduous; leaves ovate to ovate-elliptic, 6–9 cm. long, 4–7 cm. wide, coriaceous, shining, glabrous and with impressed primary venation above, dull, with elevated primary venation, and very finely reticulate-veined beneath, sparingly

pubescent on the stronger veins, obtuse at the apex, cordate at the base, the stout, brown petioles 1 cm. long, densely appressed-pubescent; inflorescence terminal, subcapitate, about 9-flowered; bracts lanceolate, densely pubescent; flowers nearly sessile; calyx subtruncate, densely appressed-pubescent, 4 mm. long; corolla white, densely villous-pubescent, in bud about 15 mm. long.

Between Rio Yamaniguey and Camp Toa, northern Oriente, at 400 m. alt. (*Shafer 4193*).

15. GUETTARDA ZYGOPHLEBIA C. Wright; Sauvalle, Anales Acad. Habana **6**: 124. 1869

TYPE LOCALITY: Arroyo in the Cafetal Potosi, Monte Toro, Oriente.

DISTRIBUTION: Known only from the type locality.

16. GUETTARDA CALYPTRATA A. Rich. in Sagra, Hist. Cub. **11**: 21. 1850

TYPE LOCALITY: Near Canasi, Cuba.

DISTRIBUTION: Woods and thickets, Santa Clara, Matanzas, Havana, Pinar del Rio, Isle of Pines. Endemic.

ILLUSTRATION: A. Rich. in Sagra, *loc. cit.*, *pl. 46*.

17. GUETTARDA MONOCARPA Urban, Symb. Ant. **7**: 410. 1912

TYPE LOCALITY: Pine-lands, Sierra Nipe near Woodfred, northern Oriente.

DISTRIBUTION: Woods and thickets, mountains of northern Oriente. Endemic.

18. GUETTARDA VALENZUELANA A Rich. in Sagra, Hist. Cub. **11**: 20. 1850

Guettarda bracteata Griseb. Mem. Am. Acad. II. **8**: 506. 1862.

TYPE LOCALITY: Vuelta de Abajo (Pinar del Rio), Cuba.

DISTRIBUTION: Mountains of Pinar del Rio and of northern Oriente. Endemic.

I am referring Grisebach's species to that of A. Richard with some hesitation, as did Grisebach himself (Cat. Pl. Cub. 131. 1866), but specimens from Bahia Honda, Pinar del Rio (*P. Wilson 9441*) do not appear different from several from Oriente, including a co-type (*Wright 261*) from Monte Verde.

19. **Guettarda calcicola** sp. nov.

A tree up to 5 m. high, with slender branches, the young twigs densely appressed-pubescent. Stipules ovate, appressed-pubescent with long hairs, about 4 mm. long; leaves oblong-elliptic to ovate-lanceolate, membranous, 4–8 cm. long, 3.5 cm. long or less, acuminate at the apex, acute or acuminate at the base, shining, prominently pinnately veined, with slender, ascending veins, loosely reticulate-veined and sparingly appressed-pubescent on the veins above, appressed-silky beneath, the slender petioles 3–8 mm. long; inflorescence axillary; peduncles slender, as long as the leaves or shorter, several-flowered; calyx subtruncate, appressed-pubescent, about 1.5 mm. long; young fruit oblong to oblong-obovoid, densely finely appressed-pubescent, about 5 mm. long, crowned by the calyx-limb.

Limestone rocks, near Sumidero, Pinar del Rio (*Shafer 13454, type*).

In leaf-venation and pubescence similar to the Haitian *G. multinervis* Urban, which has globose fruit.

20. GUETTARDA LINDENIANA A. Rich. in Sagra, Hist. Cub. 11: 20. 1850

TYPE LOCALITY: Near Santiago, Cuba.

DISTRIBUTION: Lower and middle elevations, Oriente. Endemic.

21. GUETTARDA BREVINODIS Urban, Symb. Ant. 7: 404. 1912

TYPE LOCALITY: Cuba.

DISTRIBUTION: Rocky limestone hills, Pinar del Rio. Endemic.

This does not appear to me to be certainly distinct from the following.

22. GUETTARDA INAEQUIPES Urban, Symb. Ant. 7: 405. 1912

TYPE LOCALITY: Cuba.

DISTRIBUTION: Known only from the type specimens (*Wright 2702*, in part), their exact station not recorded. This and the preceding species were referred by Grisebach to *G. membranacea* Sw., of Hispaniola, and by Wright to *G. Lindeniana* A. Rich.

23. GUETTARDA ELLIPTICA Sw. Prodr. 59. 1788

G. reticulata Griseb. Mem. Am. Acad. II. 8: 506. 1862.

TYPE LOCALITY: Jamaica.

DISTRIBUTION: Thickets at low elevations near the coasts, Oriente; Camaguey; Santa Clara; Matanzas; Havana:—Florida; Bahamas; Jamaica; Hispaniola; Porto Rico; Mexico. Referred by A. Richard and by Grisebach to *G. odorata* Lam.

ILLUSTRATION: Sargent, Sylva N. A. *pl. 229;* Man. Trees *f. 617;* Britton & Shafer, N. A. Trees *f. 768.*

24. GUETTARDA SCABRA (L.) Lam. Tabl. Encycl. 2: 218. 1793

Matthiola scabra L. Sp. Pl. 1192. 1753.
G. rugosa Sw. Prodr. 59. 1788.
G. havanensis DC. Prodr. 4: 455. 1830.
G. ambigua A. Rich. in Sagra, Hist. Cub. 11: 20. 1850. Not DC.

TYPE LOCALITY: "In America."

DISTRIBUTION: Thickets and woodlands at lower elevations, Oriente; Camaguey; Santa Clara; Matanzas:—Florida; Bahamas; Hispaniola to Tortola, Anguilla, Grenada and Margarita; Central America; recorded from Jamaica.

25. GUETTARDA COMBSII Urban, Symb. Ant. 6: 48. 1909

TYPE LOCALITY: Near Cieneguita, Santa Clara, Cuba.

DISTRIBUTION: Savannas and woodlands at lower elevations, Santa Clara; Matanzas; Pinar del Rio. Endemic.

Referred by Grisebach to *G. longiflora* Griseb. of Jamaica.

26. GUETTARDA RETUSA C. Wright; Sauvalle, Anales Acad. Habana 6: 124. 1869

TYPE LOCALITY: La Loma Pelada, Palacios, Pinar del Rio.

DISTRIBUTION: Known only from the type locality and to me only from the description, which is insufficient to enable me to group the species.

43. UNDESCRIBED WEST INDIAN SPECIES

Coccolobis rumicifolia sp. nov.

A shrub, 3 m. high, with slender branches. Leaves elliptic-lanceolate, membranous, glabrous, 15 cm. long or less, 3–7 cm. wide, acutish to acuminate at the apex, obtuse, subcordate or acute at the base, the midvein nearly flat above, prominent beneath, the primary lateral veins about 12 on each side of the mid-

vein, faint above, rather prominent beneath, the ultimate venation coarsely reticulated, the petioles about 1 cm. long, the ochreae 4–5 mm. long; racemes slender, simple, minutely puberulent, 6–12 cm. long; ochreolae subtruncate, 0.5 mm. long, about as long as the bracts; flowering pedicels spreading, 1–3 at each ochreola, 1 mm. long; perianth about 1.5 mm. long, its lobes obtuse.

Wooded hillside, Tea Gully near Newmarket, Jamaica (*Britton 1592*).

Portulaca caulerpoides Britton & Wilson, sp. nov.

Perennial, prostrate, forming tufts 8–12 cm. in diameter; stems slender, branched, hairy in the axils. Leaves obovoid, 3–5 mm. long, 2–3 mm. broad, not at all flattened, rounded at the apex, narrowed at the base, subsessile, glabrous, shining, with labyrinthine or tortuous mottling; flowers terminal, solitary, sessile; sepals oval; petals pale yellowish-white, broadly obovate, 2.5–3 mm. long, 2–2.5 mm. broad, notched at the apex; seeds reniform, black, 0.5 mm. broad, rugulose.

Limestone rocks, Cayo Muertos, Porto Rico (*Britton, Cowell & Brown 4990*).

The aspect of this species is similar to that of the green alga *Caulerpa clavifera*, which occurs in the adjacent sea.

Chamaecrista jamaicensis sp. nov.

A shrub up to 1.3 m. high, the slender branches appressed-pubescent. Stipules lance-subulate, acuminate, striate, 2–4 mm. long; petioles 6 mm. long or less, bearing a nearly cylindric gland 1–1.5 mm. long near the lowest pair of leaflets; rachis pubescent; leaflets 4–8 pairs, dull, coriaceous, sessile, glabrous, oblong, or the two upper ones oblong-obovate, 13–22 mm. long, 8 mm. wide or less, prominently many-veined, obtuse and mucronate at the apex, rounded at the base, inequilateral; peduncles bracted, pubescent, 1-flowered, shorter than the leaves; bracts lanceolate, long-acuminate, striate, about 4 mm. long; sepals lanceolate, acuminate, about 1 cm. long, broadly scarious-margined, pubescent on the back with scattered, appressed hairs; petals obovate, short-clawed, somewhat unequal, about as long as the sepals; longer anthers 9 mm. long; pod obliquely linear, 3–4 cm. long, about 6 mm. wide, pubescent with scattered hairs.

Dry soil near the southern coast of Jamaica. Type from the south slope of Long Mountain (*Britton 811*).

Referred by Grisebach to *Cassia polyadena* DC., originally from

Guadaloupe; I studied the type specimen of *C. polyadena* in the Candollean herbarium at Geneva a number of years ago; it is, in my opinion, specifically distinct from the Jamaica plant.

Rhamnidium ellipticum Britton & Wilson, sp. nov.

A glabrous tree 8 m. high; leaves narrowly to broadly elliptic, occasionally somewhat obovate, 3.5–6.5 cm. long, 1.3–3 cm. broad, obtuse or rounded and usually emarginate at the apex, rounded or obtuse at the base, coriaceous, entire, above lustrous, the midvein and primary veins indistinct, pale beneath, the midvein and primary veins prominent; margin revolute; petioles 5–6 mm. long, channeled; peduncles 1.5–3 cm. long, few-flowered; pedicels 5 mm. long; calyx-lobes triangular-ovate; fruit obovoid, 1 cm. long, 6 mm. broad, glabrous.

Rocky hillside along trail, Rio Yamaniguey to Camp Toa, Oriente, Cuba (*Shafer 4005*).

Rhamnidium Shaferi Britton & Wilson, sp. nov.

A glabrous tree 3 m. high; leaves oblong-oval to oval, occasionally ovate-oval, 5–6.5 cm. long, 3–3.8 cm. broad, rounded and emarginate at the apex, cordate at the base, lustrous above and indistinctly reticulate-veined, beneath paler, the midvein and primary veins prominent; petioles 9–15 mm. long, narrowly grooved; peduncles 7–10 mm. long, few-flowered; pedicels 3 mm. long; buds ovoid.

Camp La Gloria, south of Sierra Moa, Oriente, Cuba (*Shafer 8192*).

Rhamnidium (?) **cubensis** Britton & Wilson, sp. nov.

A shrub 3 m. tall, with grayish bark and puberulent twigs. Leaves oblong-elliptic to narrowly oblong-ovate or oblong-obovate, 2–4 cm. long, 1–1.6 cm. broad, rounded and emarginate at the apex, obtuse at the base, entire, lustrous above, the primary veins prominent, reticulate-veined and paler beneath, rigid, glabrous, black-dotted, the petioles 2–3.5 mm. long, puberulent above and shallowly channeled; flower-clusters lateral, axillary; sepals triangular-ovate, acuminate, glabrous, with a conspicuous row of black glands paralleling the margin; petals hooded, broadly triangular-obovate; filaments subulate, glabrous; anthers ovate; ovary ovoid, glabrous; ovules one in each cavity.

Rocky coastal hills, vicinity of El Morro, Santiago Bay, Oriente, Cuba (*Britton & Cowell 12554*).

Nashia cayensis sp. nov.

A densely branched, aromatic shrub, the slender pendent branches finely rough-pubescent. Leaves ovate to elliptic, 15 mm. long or less, 5–9 mm. wide, obtuse or acutish at the apex, mostly rounded at the base, scabrous above, pubescent and glandular beneath, strongly few-veined with the venation impressed above, prominent beneath, the petioles about 1 mm. long; heads solitary in the axils, nearly sessile, globular and about 5 mm. in diameter when in flower, oblong-cylindric and 10–15 mm. long in fruit, densely many-flowered; bracts broadly ovate to obovate, pubescent and ciliate, about 3 mm. long; calyx of 2 narrowly spatulate sepals nearly as long as the corolla; corolla greenish, scarcely longer than the bracts, the somewhat irregular limb about as long as the campanulate tube; filaments very short; fruit orange-red, about 2 mm. in diameter.

Near Pueblo Romano, Cayo Romano, Camaguey, Cuba (*Shafer 2450*). Similar to *Lippia myrtifolia* Griseb., and clearly congeneric with the generic type, *N. inaguensis* Millsp.

Exostema stenophyllum sp. nov.

A shrub, up to 2 m. high, glabrous throughout, the slender twigs rather densely leafy. Leaves linear to linear-oblanceolate, 6 cm. long or less, 4–6 mm. wide, subcoriaceous, obtusish or acute at the apex, narrowed to the sessile base, revolute-margined, the midvein impressed above, prominent beneath, the lateral venation wholly obscure; stipules semicircular or short-ovate, obtuse, mucronulate, about 2 mm. long; flowers terminal, solitary; peduncle 1–1.5 cm. long; calyx narrowly campanulate, 8–10 mm. long, its ovate-lanceolate acute teeth about one-third as long as the tube; corolla white; corolla-tube about 14 cm. long, 1.5 mm. thick; lobes of the corolla-limb linear, 2–3 cm. long; anthers narrowly linear, about 18 mm. long and about as long as the filaments; capsule oblong, 1.5–2.2 cm. long, about 8 mm. in diameter.

Among rocks at the water's edge, Rio Guayabo above the falls, 450–550 m. alt., Oriente (*Shafer 3623*).

The effect of the host on the morphology of certain species of Gymnosporangium

B. O. Dodge

(WITH PLATES 28 AND 29)

The large number of rather closely related species of *Gymnosporangium* which have been described as infecting such host plants as the red cedar, *Chamaecyparis*, the juniper, etc., on the one hand, and the hawthorns, apples, shad-bush, etc., on the other, raises the question as to the relation of the particular host to the specific differences in the parasite.

It is commonly accepted (17, 18) that certain species of *Gymnosporangium* gain entrance into the tissues of the coniferous host through leaf infection. In the case of *G. macropus* on the red cedar, strictly foliicolous galls are often quite numerous. To what extent species of *Gymnosporangium* are perennial and whether in such cases sori may develop on the leaves as well as on the branches or trunk does not appear to have been definitely determined in many species. Reed and Crabill (18) claim that the mycelium of *G. macropus* never penetrates beyond the base of the leaf into the twig. The leaf forms which Farlow (3) referred to *G. clavipes* were later found to belong to *G. nidus-avis*, now believed to develop on all parts of the red cedar. When the trunk or branches are attacked the bark is split open or deeply furrowed. The same species may produce the witch's-broom or bird's-nest malformations, and isolated sori may even be found at the base of the leaves or possibly on the leaves themselves. Farlow and Thaxter, in their later publications (4, 20–22), cleared up the points relating to the identity of *G. nidus-avis*, so that one is not left in doubt as to their conceptions of the variations and limitations of this "multiform species."

I am studying a somewhat similar case in connection with *G. biseptatum*, which is perennial in the branches or trunk of *Chamaecyparis*. The teleutospores are commonly three- or four-celled,

but there also occur numerous two-celled spores mixed in with the others. Certain specimens confined to the leaves were distributed by Seymour and Earle as *G. biseptatum* var. *foliicolum* (Econ. Fungi *244*). Ellis also found this variety at Newfield, New Jersey (N. Am. F. *1479*). Farlow's comments clearly set forth the essential facts in regard to the two forms, and I quote the following paragraph from his early work on the *Gymnosporangia* of the United States (3): "The spores of the present species (*G. biseptatum*) are characterized by the great variability in the number of cells of which they are composed. The most usual number is three or four, two are rather common and occasionally there are as many as six. . . . The spores of the present species when full grown are not easily mistaken for those of any other species, but the young tufts on the leaves often bear spores which are all, or nearly all, two-celled. I have received specimens from Mr. Ellis, with the fungus confined to the leaves, and it was difficult to say to what species to refer it. Large sets of specimens collected at Newton, however, show that while the young spots on the leaves may have principally two-celled spores, those on the smaller branches have about an equal proportion of two- and three-celled spores, and the still older branches have a large proportion of three-celled spores. In short, the variability is so great that without a large set of specimens, one would have difficulty in convincing himself that the extreme forms belonged to the same species." It should be noted that Farlow has apparently seen spores with more than two cells in the leaf sori. Thaxter (**20**) first showed the connection between *G. biseptatum* and *Roestelia Botryapites* on *Amelanchier*, but I do not find that he produced the infection by using spores from sori on the leaves.

Kern (**9**) describes this leaf form on *Chamaecyparis* as a new species under the name *G. fraternum*, on the basis of "its habit and morphological characters distinct from *G. biseptatum*."

Jackson (**8**) and Meineke (**12**) have found witch's-brooms on *Libocedrus*, supposed to be caused by *G. Blasdaleanum*, which has hitherto been thought to be strictly foliicolous (**9**, **10**). Jackson used spores from such specimens and found that the aecidia produced were the same as those derived from infections with spores from the leaf form. This species furnishes an example of

a most striking case of uniformity in the characters of the aecidial stage when developed on hosts of different genera. O'Gara (13) and Jackson (8) have been able to infect species in six different genera of the apple family with this rust. *Malus*, *Pyrus*, *Sorbus*, *Cydonia*, *Amelanchier* and *Crataegus* are susceptible. The constant uniformity of the aecidia on these different hosts, and their "conformity to type" of well authenticated specimens of this rust are their main reliance in assuming that they are working with *Gymnosporangium Blasdaleanum* on the *Libocedrus*.

On the other hand, Pammel (14) has given some data relative to the variations occurring in the aecidiospores and peridial cells when the aecidia of *G. macropus* are found on different host plants. The conditions under which his experiments were made are not given. He reports the infection of the wild crab and *Crataegus mollis* with *G. macropus*, and figures peridial cells and spores from aecidia on each of these hosts and on the common apple. There are noticeable differences in the size, form, and markings of these cells. He says: "In *Crataegus punctata* as well as *C. mollis* the peridial cells extend much longer beyond the surface of the leaf, and they are more finely lacerate. In *Pyrus Iowensis* the cups are shorter, darker brown, and the peridial cells do not cling together as in the *Crataegi*. In the cultivated apple the cups are smaller than [on] either of the other host plants. They project but slightly beyond the surface." It is a common practice, where the aecidial host is known to harbor several species of *Gymnosporangium*, to consider the peridial cells as the most satisfactory means of determining the species of rust, just as the markings on the ascospores of certain species of Discomycetes are thought to be good specific characters. It is well known that the cells at the apex of the peridium differ in length from those at the base, but the shape and markings have been assumed to be fairly constant.

Long (11) has also recently reported variations in *Puccinia Ellisiana* when grown on *Viola* and on *Pentstemon*. On the former host the aecidia are from one to four times as long, are greater in diameter, are deeper in color, have more peridial segments, and dehisce more tardily, while the aecidiospores are smaller than when the rust is grown on *Pentstemon*.

On April 29, 1911, I accompanied Dr. F. D. Kern (see Arthur, 1a) to Newfield, New Jersey, where we found a few specimens of *Gymnosporangium fraternum* in Holton's swamp, and also a quantity of *G. biseptatum*.* Visits made to Newfield and Lakehurst at various times since have afforded opportunity for further study of this stage of the rust.

During the first week in January the most careful inspection of several small marked cedars in the field failed to disclose any positive evidence of infection. Some of the leaves were slightly discolored or bore yellowish spots which contained what appeared to be a resinous substance but no spores. By the middle of March there were many leaves which were of a light waxy-yellow color throughout, and occasionally one could find, with the aid of a lens, lines of eruption from which teleutospores were just emerging. Sori were fully developed by the second week in April. The discoloration of the entire leaf seems to be confined to those which later bear very large sori. Where the sorus is comparatively small (PLATE 28, FIG. 1) the unoccupied parts of the leaf remain green. Infected leaves die off after the sori have disappeared through gelatinization. On June 1, 1914, it was not difficult to find sori, but they showed that in spite of the fact that it had been a very dry season, they had been previously swollen. Spores from these sori gave a low percentage of germination.

Greenhouse cultures, described later, indicate that the development of the sori can be hastened by at least two months. On the other hand, if small cedars are brought in from nature in the last week of March the "forcing process" is not especially effective. The same is true for *G. biseptatum*. Living branches with the fusiform swellings were obtained from Newfield March 21 and kept well watered and sprinkled. The first spores available for inoculation were ready April 13. At this time in nature their condition was much more satisfactory.

There is a great amount of variation in the shape, size, and the thickness of the walls of the spores of the foliicolous form. I have

* I shall use the name *G. biseptatum* to designate the perennial form now sometimes called *G. Botryapites*, and distinguish the foliicolous form on the same host by the name *G. fraternum*, since it will appear from what follows later that there must still be some uncertainty regarding the connections of the original "type," *Roestelia Botryapites*.

not found spores that had more than two cells. Kern (9) states that each cell has two pores near the septum. In the great majority of the spores the upper cell has a pore at the apex, and it is more frequently through this pore (PLATE 29, FIGS. 33–35, 37) that the germ tube appears. The pedicel possesses a characteristic feature noted by Farlow (3) in his discussion of "*G. clavipes*." The "collar," which remains attached to the lower end of the spore after the pedicel has swollen and has more or less disappeared through gelatinization, is apparently the upper portion of the stalk cell wall which becomes disorganized for the most part when moistened. The upper end still persists along with the protoplast which is seen as a long thread-like appendage. The stalk cell is originally cylindrical as described by Kern (9), but when moistened it frequently becomes carotiform (FIG. 26), resembling in this condition the pedicel of *G. clavipes*, though the thickening is much less noticeable. The two-celled spores of *G. biseptatum* resemble in every respect the spores of *G. fraternum* (FIGS. 31, 32).

On April 19, 1914, I found at Newfield a large quantity of *G. fraternum* on seedlings of *Chamaecyparis* a few inches high as well as on trees of all sizes. In a few cases the same branches bore both *G. biseptatum* and *G. fraternum*. The latter also occurred on small trees which were at the same time heavily infected with the witch's-brooms of *G. Ellisii*. At the place where *G. fraternum* was the most abundant there was a good growth of *Amelanchier* and *Aronia*. The leaf buds of the shrubs had not opened to any great extent, and there were no indications that the sori of the *Gymnosporangia* had reached sufficient maturity to have swollen and scattered sporidia during any rains that may have occurred previous to this date. The season was somewhat "late."

Infected seedling cedars were brought in and potted, and root sprouts of *Amelanchier*, *Aronia*, and *Pyrus* were also obtained from this locality and from the grounds of the New York Botanical Garden. It required five or ten days for the leaf buds to open sufficiently for these plants to be used for inoculation purposes; at the end of this time the sori on the cedars had also reached maturity.

Inoculations were made in the greenhouse, and the usual

methods, with slight modifications, were employed. Branches of cedar whose leaves bore sori were sprayed and hung over the trial host, which was then covered with a bell-jar for forty-eight hours. Two or three times during this interval the bell-jar was aired out and the plant sprayed. The sori of *G. fraternum* are so small that there is little danger of killing the alternate host by over infection. A larger number of plants can be more easily inoculated with a small supply of teleutospore material if the sori of germinating spores are shaken in a bottle with water so that the sporidia can be sprayed on the plants directly. The infection chamber mentioned by Fromme (5) has been employed with great advantage. This chamber is constructed by uniting five three-foot window sashes in the form of a box; the front sash is provided with hinges. It is large enough to hold fifteen or twenty plants in four- or six-inch pots, and plants up to two feet high can be inoculated easily under such conditions. The chamber can be aired out and the plants sprayed with little trouble. Another advantage to be gained by the use of this apparatus is the opportunity one has of providing similar conditions for several plants of different species which are being tried out. The old method of using leafy twigs instead of potted plants was also employed with more or less success.

The records contained in Table I* include only those cases in which the recently transplanted host lived fifteen days after inoculations were made. The Aronias from Newfield were badly spotted with small insect galls. The percentage of positive results was no doubt reduced on this account. The dates given in the last four columns refer to the time at which this particular stage was first observed although the fungus may have reached this stage some time previously and been overlooked. Where a date is replaced by a question mark (?) the aecidia were not seen until dehiscence was complete.

The plants used in these trials were chiefly species of *Aronia* and *Amelanchier*. As a large number of leaves on plants of these two genera first inoculated soon showed unmistakable signs of

* A preliminary report of this work has been published recently: Dodge, B. O. Relationship between *Roestelia transformans* and *R. Botryapites*. Torreya **15**: 133, 134. Je 1915.

infection, most of the succeeding experiments were carried out to check up the first results.

It is probable that no importance need be attached to the results obtained in numbers 200 and 221. Only one leaf on each apple seedling was infected, and this might have been due to the presence in the greenhouse of young red cedars bearing *G. macropus* and *G. globosum*. No aecidia developed on these leaves. Farlow (3) and Seymour (19) report *Roestelia transformans* on the cultivated apple. The pear and hawthorn were not infected, but as only one or two plants were tested these results are also inconclusive.

The table shows that about 50 per cent. of the Aronias were infected. Three different species were employed and all gave positive results. Aecidia matured on certain plants of *A. arbutifolia* and *A. nigra*, but the fungus on *A. atropurpurea* did not develop further than the formation of the large primary hypertrophies.

The interval between inoculation and the first appearance of the discoloration indicating infection varies from ten to fifteen days. The areas on the *Aronia* are not especially characteristic. They become raised or convexed and are frequently four or five millimeters in diameter (FIG. 3). After some days, ten to twenty, the parts attacked become sunken as the hypertrophies develop into bright green swellings directly beneath the pits. The galls sometimes seem to be three or four millimeters thick, but this apparent thickness is due in part to the pit in the upper surface of the leaf.

The horn-like processes of the galls (FIG. 4) begin to grow out a week or two later, after which the aecidia quickly develop and reach maturity within two months after inoculation. Frequently the development does not proceed further than the formation of the basal galls. The leaf remains in this condition for several weeks and new spermogonia are formed continually on the galls. Normally aecidia are matured whenever the cornute galls are developed.

FIGS. 7 and 8 show a case in which the growing point of a twig has been entirely transformed by the fungus. Eight weeks elasped between the taking of the photographs.

Occasionally infected leaves curl up soon after spermogonia

TABLE I

RECORD OF INFECTION EXPERIMENTS WITH THE FOLIICOLOUS FORM ON *Chamaecyparis* (*Gymnosporangium fraternum* KERN) IN 1914

No.	Trial host	Date inoc.	Spermogonia observed	Hypertrophy	Gall-horns	Aecidia appeared	Aecidia mature
200	*Malus Malus*	Apr. 25	June 15†				
201*a*	*Aronia nigra**	Apr. 23	May 5	May 19	July 28‡		
201*b*	*Aronia arbutifolia*	Apr. 23	May 5	May 19	June 5	June 18	June 21
202*a*	*Aronia nigra*	Apr. 25	May 6	June 10	July 1	July 12	July 24
202*b*	*Aronia arbutifolia*	Apr. 25	May 6	June 14	July 10	July 15	July 20
203*a*	*Amelanchier intermedia*	Apr. 25	May 6	May 25	June 14†		
203*b*	*Aronia arbutifolia*	Apr. 25	May 6	May 19	May 27	June 3	June 10
204	*Pyrus communis*	Apr. 25					
205	*Pyrus communis*	Apr. 25					
221	*Malus Malus*	Apr. 27	June 23§				
222	*Crataegus oxycantha*	Apr. 27					
242	*Aronia nigra*	May 6					
243	*Amelanchier Amelanchier*	May 6	May 19	May 28§			
245	*Amelanchier intermedia*	May 6	May 20§				
246	*Amelanchier intermedia*	May 6	May 17	June 4	Aug. 20	?	Sept. 10
249	*Amelanchier intermedia*	May 6	May 25§				
250	*Aronia arbutifolia*	May 6					
251	*Aronia arbutifolia*	May 6					
252	*Aronia arbutifolia*	May 6	May 16	May 24	June 12	June 25	July 5
253	*Aronia arbutifolia*	May 6	May 17	May 24	June 12	June 20	June 22
254	*Aronia arbutifolia*	May 6					
255	*Amelanchier intermedia*	May 6					
256	*Aronia arbutifolia*	May 6					
257	*Aronia arbutifolia*	May 6	May 19	June 15§			
258	*Aronia arbutifolia*	May 6					
259	*Aronia arbutifolia*	May 6					
265	*Aronia arbutifolia*	May 6					
267	*Aronia arbutifolia*	May 6	May 19§				
268	*Aronia arbutifolia*	May 6	May 16	May 26	June 6	June 17	June 20
269	*Aronia arbutifolia*	May 6					
270	*Aronia arbutifolia*	May 6	May 20	June 12§			
271	*Aronia atropurpurea*	May 11	May 26	June 12§			
272	*Aronia atropurpurea*	May 11					
273	*Aronia atropurpurea*	May 11					
274	*Aronia nigra*	May 11					
275	*Aronia nigra*	May 11					
277	*Aronia nigra*	May 11					
278	*Amelanchier intermedia*	May 11					
279	*Aronia nigra*	May 11	May 26	June 12†			
281	*Amelanchier intermedia*	May 11					
283	*Aronia nigra*	May 11	May 26	June 3	June 12	June 20	June 22
284	*Aronia nigra*	May 11					
344	*Aronia nigra*	June 3	June 21	July 20	Aug. 1	Aug. ?	Aug. 14

No.	Trial host	Date inoc.	Spermogonia observed	Hypertrophy	Gall-horns	Aecidia appeared	Aecidia mature
365	*Aronia arbutifolia* . . .	June 3	June 21§				
366	*Aronia arbutifolia* . . .	June 3					
368	*Aronia arbutifolia* . . .	June 3	June 23	July 10	July 14	July 18	July 23
372	*Aronia atropurpurea* .	June 3	June 12	June 28§			
373	*Aronia atropurpurea* .	June 3					
375	*Aronia nigra*	June 3	June 15	July 12	July 18	Aug. ?	Aug. 10

* Numbers 201*a*–205, and 279 were leafy twigs; all of the others were potted plants.

† Leaves died.

‡ Killed by "mealy bugs."

§ No further growth.

appear (FIG. 10), but the majority are not materially altered in shape (FIG. 12). FIG. 9 shows how the fungus may also attack young twigs below the growing point. A large number of aecidia develop on such malformations and on the fruit when it is attacked.

The aecidia are about one half millimeter in diameter and two to five millimeters in height, tapering gradually to a fine point (FIG. 15). Frequently those on *Aronia nigra* (FIG. 18) are taller. The dehiscence of the peridium is shown in FIGS. 15, 16, and 17. The cells at the apex do not split apart, and, as a result of the laceration of the portion of the peridium below the apex (FIG. 16) and the reaction of the mature cells to atmospheric changes, the top breaks away (FIG. 19), leaving the lower part of the cup fringed with a tangle of cells. The inner surface of a peridial cell is coarsely warted and most of them are pointed. Some have a notch at one end (FIG. 41), showing that they may overlap or dovetail. The only species known to possess such peridial cells is *Roestelia transformans*, the species that produces hypertrophies on *Aronia* such as I have described. The peridium is said (**9**, **16**) to dehisce at the apex first and gradually fall away. It is likely that collectors have failed to note the manner in which the tip end disappears. The galls are green until long after the aecidia are mature and not brownish as one finds them in dried specimens.

The twigs of *Amelanchier intermedia* used in number 203*a* were obtained at Newfield April 19 and inoculated April 25 with sporidia taken from swollen sori of *G. fraternum*. Spermogonia appeared on several leaves May 6. A potted root sprout of *A. intermedia* also from Newfield was used for number 249. At the

time of inoculation, May 6, the leaves were well out. A few infected areas appeared May 25 but no "subicular hypertrophies," projections, or aecidia subsequently developed. Similar root sprouts of *Amelanchier Amelanchier* and *A. intermedia* from the New York Botanical Garden were used in numbers 243 to 246, and 255. Spermogonia appeared on several in each case except in number 255, but the only one to mature aecidia was number 246. On June 4 hypertrophies were visible, which possessed characteristics quite different from those formed on the Aronias. At each point of infection on the *Amelanchier* leaves there were from two to six separate galls which grew to be about one or two millimeters high by July 22 as shown in FIG. 20. During the next three weeks the tubercles elongated slightly (FIGS. 21, 22). Aecidia reached maturity September 10. FIG. 43 shows an optical section of a peridial cell from the central part of an aecidium. The entire surface is smooth. The walls are not always of uniform thickness and the lumen does not appear to extend the full length of the cell. It is difficult to obtain such a view of an outer or inner surface of the cells of the peridia on *Aronia*. Those on the *Amelanchier* do not coil up in water to any great extent and, as they are merely "wavy" in outline, views of all sides may be obtained. Cultures made later show that two or three tubercular galls occasionally coalesce (FIG. 21) forming a solid mass of tissue from which the same number of aecidia develop. The basal gall subiculum on *Aronia* is often conspicuous from the first (FIG. 4). The horn-like parts are secondary. This is also in a measure true for the fungus on *Amelanchier*, where there is a very slight primary swelling, and one can not tell at first just how many ovoid outgrowths, and therefore how many aecidia, will be formed at any particular point of infection.

It is unnecessary to describe this rust as it appears on *Amelanchier* further at this point than to say that in the characters of the peridial cells and in the manner of dehiscence it corresponds very well in general with exsiccati specimens of *Roestelia Botryapites* on *Amelanchier* or to the original description of *R. Ellisii*, which has long been considered a synonym of *R. Botryapites*. In spite of the fact that no *Gymnosporangium biseptatum* was kept in the greenhouse the possibilities of contamination or mixture of

spores in the field at the time of collection were so great that, likewise, I should have attached no importance to these results were it not for the suggestions by Farlow (3) and others of a possible relationship between the ordinary perennial caulicolous form on *Chamaecyparis* and the "annual" leaf form on the same tree.

Comparing "*Gymnosporangium fraternum* on *Aronia*" and "*G. fraternum* on *Amelanchier*" we see two noteworthy differences: (1) the effect on the host; (2) the characters of the aecidia themselves. *Roestelia transformans* ("*Gymnosporangium fraternum* on *Aronia*") sometimes entirely transforms the terminal buds so that a large number of aecidia are produced on a massive gall; the same type of swelling may occur on young branches (FIGS. 7–9). The leaf may be more or less bent or deformed (FIG. 10). The aecidia arise in long horn-like projections of the host. In a majority of cases, however, in my cultures, as noted above, the *Aronia* leaves are not deformed and the primary or basal hypertrophy is not always prominent (FIG. 12).

Each aecidium of "*G. fraternum* on *Amelanchier*" arises from a gall which is more wart-like or ovoid. FIG. 20 shows such galls; the spot in the center of each indicates where the peridium will grow out. FIGS. 21–25 show further stages. The peridial cells are strikingly different in the two forms. They are very long in both cases. The cells from *Amelanchier* are irregularly bent or hypha-like and smooth on both surfaces (FIG. 43), while in those from *Aronia* the inner surface is invariably roughened with several series of warts (FIG. 41). The forms of the galls from which the aecidia arise are such as might be due to the reaction of different hosts to the stimulus of the same fungus.

The published infection experiments with *G. biseptatum* are very few. Certainly the possibility remains that *Aronia* can be infected with sporidia from the perennial caulicolous form. Arthur (1a) reports the infection of *Aronia* with *G. effusum*, and Kern (10) suggests that *G. effusum* and *Roestelia transformans* are possibly connected. Tubeuf, Saccardo, Sorauer, Pammel, and others have published more or less as a fact the connection between *G. Ellisii* and *Roestelia transformans*. I have repeated Fromme's (6) experiments with *G. Ellisii* and easily succeeded in infecting

Myrica caroliniana. Spermogonia appeared in seven days. Aecidia were ripe within four weeks. Four plants of *Comptonia* and ten of *Aronia* were inoculated at the same time in the same chamber, with negative results.

With the alternate hosts of *G. Ellisii* and *Roestelia transformans* known, only one phase of the question has been solved.

It is a common practice in establishing a connection between two phases of a heteroecious rust to rest content when the rust has been carried from one plant to the alternate host. The unsatisfactory state of our knowledge of several species of the genus *Gymnosporangium* is due in large part to the reluctance of investigators to undertake a piece of work involving such a length of time, and beset with difficulties such as they would be confronted with in any attempt to carry back the infection from the aecidial to the telial host. Plowright (17) and Arthur (1) appear to be, so far as I have learned, the only persons who report having carried such work through.

If the *Gymnosporangium* is a perennial then the number of years the telial host must be kept under strict control conditions before inoculations are made is no less serious a question than the time required to allow the rust to make its effects evident.

In case *Gymnosporangium fraternum* is confined to the leaves of the cedar and is annual, the converse infections should not be extremely difficult to get. If, on the other hand, the rust maintains itself in the wood tissues producing sori on new leaves each year, or after a number of years on the trunk or branches, the history of the successful experiment will be a long one. I have undertaken to carry on some work along this line, and in recording the results so far obtained I do not make any claim to have settled the questions involved.

INOCULATION OF *Chamaecyparis* WITH "*Roestelia transformans* ON *Aronia*"

Twenty-one cedars varying in height from four to twenty inches were brought from Newfield in April, 1914, and potted in the soil in which they had been growing. Some of them were heavily loaded with sori of *G. fraternum* at the time; others had only a few; eleven had none, so far as could be found.

Aecidia had begun to ripen on the Aronias (see Table I) about the middle of June and continued to shed spores for some time. The method of inoculation employed consisted in putting several cedars and Aronias bearing aecidia in the infection frame together and, in addition, the cedars were sprayed with aecidiospores. After two days in the frame, the plants were taken out and stacked together on the bench. This treatment was repeated two or three times with some of the cedars at intervals of about a week. No attempt was made to infect the cedars with spores from "*Gymnosporangium fraternum* on *Amelanchier*."

Certain of these cedars were "sunk" in the garden during the month of October and then put in the cold frame; others were left in the greenhouse until December or January and then put in the cold frame; those remaining were kept in the greenhouse all winter.

Beginning about the first week in December the cedars were removed from the cold frame one by one until all had been brought in by March. A very careful inspection of the plants as they were taken from the frame showed that no sori had developed. The results may be summarized under the five groups into which the plants may be divided according to their previous treatment or condition.

TABLE II

INOCULATION OF *Chamaecyparis thyoides* WITH *Roestelia transformans* ("*Gymnosporangium fraternum* ON *Aronia*") IN 1914

Plants free from sori in spring of 1914						Plants having sori in spring, 1914			
Inoculated June, July			Control, not inococulated			Inoc. June, July			Control†
No.	Result	Date	No.	Result	Date	No.	Result	Date	
		(1915)						(1915)	
432	+	Mr. 24	345	0		419	+	Jan. 22	
437	+	Mr. 26	346*	0		347	+	Feb. 7	
400	+	Mr. 29	433	0		404	+	Feb. 19	
445	+	Apr. 22	436	0		421	+	Mr. 5	
406	−		424a	0		435	+	Mr. 29	
409	−					348	+	Mr. 30	
						410	+	Mr. 30	
						420	−		
						434	−		
						349	−		

* Numbers 346, 404, 406, 420, 437, and 445 were kept in the greenhouse all winter; the others had been in the cold frame for from one to three months.

† All available plants having sori in the spring of 1914 were inoculated on the questionable assumptions that they would be more susceptible and that the mycelium is annual in the cedar.

The table shows that of the eleven cedars not having sori in 1914 five which were not inoculated developed no sori in 1915. Six were inoculated and four of them bore sori in 1915. Ten plants had sori in 1914 and all of these were inoculated, seven of them producing teleutospores in 1915. The first to show infection had been put in the cold frame October 29 and was brought in December 9. Two sori were discovered January 22. Eight more had been formed on this plant by March 12.

This teleutospore material was used in making further inoculations of *Amelanchier* and *Aronia* to check up the results obtained in 1914. Owing to the limited supply of spores on February 22, the sori of germinating spores were rubbed on the individual leaves of *Amelanchier*. Over infection resulted and many of the leaves were killed. The results of the experiments are given in Table III.

TABLE III

INFECTION EXPERIMENTS WITH SPORES FROM LEAVES OF POTTED PLANTS OF *Chamaecyparis* THAT HAD BEEN INOCULATED WITH *Roestelia transformans* IN 1914

No.	Trial host	Date inoc.	Spermogonia observed	Hypertrophy	Gall-horns	Aecidia appeared	Aecidia mature
425*a*	*Amelanchier intermedia**	Feb. 22	Mr. 6†				
427*a*	*Amelanchier canadensis**	Feb. 22	Mr. 6‡				
441	*Amelanchier intermedia*	Feb. 22	Mr. 6	Apr. 18	May 25	June 10	June 20
449	*Aronia arbutifolia*	Mr. 7	Mr. 18	Apr. 18§			
431	*Amelanchier canadensis**	Mr. 11	Mr. 22‡				
430	*Amelanchier intermedia*	Mr. 13	Mr. 24	Apr. 22	May 23	June 10	June 27
438	*Amelanchier intermedia*	Mr. 13	Mr. 26	May 5	May 20	July 6	July 25
439	*Amelanchier intermedia*	Mr. 13	Mr. 26	Apr. 20	May 25	June 24	June 30
442	*Amelanchier intermedia*	Mr. 25	Apr. 5	Apr. 20§			
443	*Amelanchier intermedia*	Mr. 25	Apr. 10	June 1	June 20	July 4	Aug. 2
444	*Aronia arbutifolia*	Mr. 25	Apr. 12	May 1§			
447	*Amelanchier Amelanchier*	Apr. 14	Apr. 23§				

* Leafy twigs were used in numbers 425*a*, 427*a*, and 431; all others were potted plants.

† Photographed and preserved as specimens.

‡ Infected leaves all killed.

§ No further growth.

There were ten different plants of *Amelanchier* including three species. Two numbers of *Aronia* were also used. The absence of failures may be attributed to the care taken in making the inoculations, and to the vigorous condition of the plants. These experiments (except number 447) were made before any teleutospore

material of *G. biseptatum* was brought into the greenhouse. It requires three or four weeks after aecidia make their first appearance on *Amelanchier* for them to reach their full length. Some of them appear to be unable to force their way out of the gall readily. The peridial cells loosen up so that spores are scattered long before the full growth of the peridium is attained (FIG. 24).

A large quantity of *G. biseptatum* was obtained at Lakehurst, New Jersey, on April 25, 1915. *G. fraternum* was not as abundant here as at Newfield, although scattering infections could be found on almost any *Chamaecyparis*.

Another set of cultures on *Aronia* and *Amelanchier* was made with *G. fraternum* from this locality. A summary of the results is given in Table IV.

TABLE IV

INFECTION EXPERIMENTS WITH *Gymnosporangium fraternum* FROM LAKEHURST IN 1915

Date of inoculation	Species of trial host	Number of plants	Positive results	Negative results
April 29	*Aronia arbutifolia*	11	9	2
April 29	*Aronia nigra*	5	5	0
April 30	*Aronia arbutifolia*	4	4	0
April 30	*Amelanchier intermedia*	1	1	0
April 30	*Amelanchier Amelanchier*	1	1	0
May 1	*Aronia nigra*	1	1	0
May 2	*Aronia arbutifolia*	8	6	2
May 2	*Amelanchier Amelanchier*	1	1	0
May 3	*Aronia arbutifolia*	6	2	4
May 3	*Amelanchier intermedia*	3	0	3
May 3	*Amelanchier canadensis*	1	1	0
May 16	*Aronia arbutifolia*	5	3	2
May 16	*Aronia nigra*	4	0	4
Totals	*Aronia*	44	30	14
	Amelanchier	7	4	3

Only a small supply of teleutospores was available May 3 and May 16. This in part accounts for the low percentage of infection on these dates. The *Aronia* leaves were rather old to expect good results. Three-fourths of the Aronias were infected and most of them developed a large number of aecidia. Four out of seven Amelanchiers were also infected. While *Amelanchier Amelanchier* was infected none of the plants of this species matured aecidia.

The question of determining whether the caulicolous form

(*Gymnosporangium biseptatum*) is capable of infecting *Aronia* was next considered. Small plants of *Aronia* and *Amelanchier* were in excellent condition at this time and the supply of teleutospore material from Lakehurst, New Jersey, was unlimited. The infection frame was used so that the different species of trial host could be subjected to the same conditions. Several branches bearing telia were hung about in the frame, and the plants were sprayed with large quantities of sporidia. Whenever Aronias were inoculated (except on April 15) one or more plants of *Amelanchier* were also used as controls. Table V also includes the results of experiments carried out in 1914. The teleutospore material used April 13–16 was obtained from Newfield.

TABLE V

INFECTION EXPERIMENTS WITH THE CAULICOLOUS FORM (*Gymnosporangium biseptatum*) IN 1914 AND 1915

Date	Trial host *Amelanchier*	Number of plants	Results +	Results —	Trial host *Aronia*	Number of plants	Results +	Results —
(1914)								
Je. 11	*A. canadensis*	1	1	0	*A. nigra*	3	0	3
" "	*A. intermedia*	1	0	1	*A. arbutifolia*	5	0	5
" "	*A. Amelanchier*	1	0	1				
(1915)								
Apr. 13	*A. intermedia*	1	0	1	*A. nigra*	3	0	3
" "					*A. arbutifolia*	1	0	1
" 15					*A. nigra*	3	0	3
" "					*A. arbutifolia*	10	0	10
" "					*A. atropurpurea*	1	0	1
" 16	*A. intermedia*	1	1	0	*A. nigra*	10	0	10
" "					*A. arbutifolia*	10	0	10
" 26	*A. intermedia*	3	3	0	*A. nigra*	11	0	11
" "					*A. arbutifolia*	8	0	8
" 29	*A. intermedia*	2	2	0	*A. nigra*	1	0	1
" "					*A. arbutifolia*	2	0	2
" 30	*A. intermedia*	6	6	0	*A. nigra*	1	0	1
" "	*A. Amelanchier*	2	2	0	*A. arbutifolia*	3	0	3
" "					*A. atropurpurea*	1	0	1
May 16	*A. intermedia*	11	11	0	*A. nigra*	7	0	7
" "	*A. canadensis*	2	2	0	*A. arbutifolia*	14	0	14
" "					*A. atropurpurea*	1	0	1
Total .	*Amelanchier*	31	28	3	*Aronia*	95	0	95

Some of the Aronias employed in making these tests were used over again for the second or even the third time. The first

sowings were made just as the first leaves were opening. When the last trials were made, May 16, there were still a few new leaves on each plant, but most of the leaves were too old perhaps to be susceptible to any rust. In order to determine this point *G. fraternum* was sowed on nine of the plants the same day (see Table IV) and three infections were obtained.

The variable length of time required for the development of the spermogonia demands that the plants should be kept under control conditions for at least a month. Arthur (2) reports sowing *G. biseptatum* on *Amelanchier canadensis* which did not develop spermogonia until after a period of twenty-five days. One of my cultures, No. 540, required thirty days. This was a shrub of *A. intermedia* about two feet high, which was transplanted from the garden April 28, after its leaves were full grown. *G. biseptatum* was sown on it April 30. The plant did not do well after it was transplanted; the leaves assumed what gardeners call the "sleepy condition." As no spermogonia were visible May 15, the plant was topped to save it. The remaining leaves soon regained their normal rigidity. On May 30 spermogonia began to appear in considerable numbers. Twenty-seven other infections were obtained on *Amelanchier*. Six showed signs of infection on the seventh day; four required eight days; ten showed in nine days; six in ten days; the one infected in the garden required thirteen days. The average incubation time of *G. fraternum* on *Aronia* and *Amelanchier* appears to be between nine and twelve days. Table VI contains a summary of these periods in some sixty experiments with *G. fraternum*.

TABLE VI

INCUBATION PERIOD OF *Gymnosporangium fraternum* ON *Amelanchier* AND *Aronia*

Incubation period, days.....	6	9	10	11	12	13	14	15	16	17	18	20	22
Number of plants: *Aronia*.....	3	12	15	5	4	4		1		1	3	1	1
" " " *Amelanchier*		1	1	4	4	3	1	1	1	1			

Gymnosporangium biseptatum (caulicolous form) will infect *Amelanchier* readily, but if it ever infects *Aronia* it must do so under different conditions from those prevailing in connection with the ninety-five attempts which I have made to bring it about.

My experiments of 1914, confirmed by those of 1915, also show that *G. fraternum* will infect *Amelanchier* about as readily as it will *Aronia*, producing on the *Amelanchier* hypertrophies and aecidia which may have furnished the basis for Peck's *Roestelia Ellisii* and which is without doubt now widely distributed in exsiccati under the name *R. Botryapites*.

Leaving aside the question of the accuracy or thoroughness of my experiments in attempting to infect *Aronia* with *G. biseptatum* the other cultures show that the foliicolous form on *Chamaecyparis* occurring so abundantly at Newfield and Lakehurst, New Jersey, is the *Gymnosporangium* connected with the well known *Roestelia transformans*.

GENERAL DISCUSSION

The color of the gall on *Aronia* produced by *Roestelia transformans* is commonly described as red or brownish. To quote from Peck (15): "Subiculum much thickened, produced into tufts of crowded subcylindrical or cornute processes, red or brownish, sometimes transforming an entire leaf."

I have noted above that the galls in my cultures remain perfectly green long after the aecidia are mature, and turn brownish only when old or after much exposure to weathering.

In 1875 Peck (16) described *Roestelia Ellisii*, collected by Ellis on leaves of *Amelanchier* at Newfield. Peck's description might well have been drawn from the form which I have obtained on *Amelanchier* by inoculation with *Gymnosporangium fraternum*: "Spots yellow, red or brown; subicular projections clustered or scattered, ovate, greenish, or yellowish; peridia cylindrical, single at the apices of projections, the laciniae remaining united at the apex, the cells linear, subflexuous, smooth. . . . This species is related to *R. transformans* Ellis, from which it differs in its paler, shorter, and differently shaped subicular projections, the smooth cells of the peridia, and the apically united laciniae." I have pointed out that in *R. transformans* on *Aronia* the apical peridial cells remain united, falling off together, and that the color of the galls varies with age. Peck could not have known of *R. Botryapites* or had it in mind when he described *R. Ellisii* for all subsequent writers have considered them identical on the basis of the "smooth flexuous cells," and the form of the galls on the host.

The galls of "*Gymnosporangium fraternum* on *Amelanchier*" are at first small wart-like growths, somewhat flattened or depressed at the center (FIG. 20). Ten or twelve weeks after inoculation the pit disappears and the gall begins to elongate, becoming ovoid (FIG. 21). The apex is marked by several rounded prominences (FIG. 25). There are no such fluted collars visible on the galls on *Aronia*. Thaxter (**20**) and Arthur (**2**) report that it requires from four to five months for the complete development of *Roestelia Botryapites* on *Amelanchier*. My records show that it takes about the same time for *Gymnosporangium fraternum* on *Amelanchier*, while on *Aronia* the aecidia mature six or eight weeks after inoculation.

Of the galls produced on *Amelanchier* when infected with *G. biseptatum* Farlow (**4**) says: "Although the peridia are not yet ripe there can be no doubt that the species is *R. botryapites*, as the tubercular swellings produced can not be mistaken for those of any other species known in this country."

I have shown that *G. fraternum* produces an aecidial form on the *Amelanchier*, which resembles very closely the aecidium known as *Roestelia Botryapites*, proved to be connected with *G. biseptatum*. It would be of no consequence whatever to draw conclusions as to the relationship of these two *Gymnosporangia*, based on even the most critical examination of the existing exsiccati of *R. Botryapites* which have all been collected in the field. There could be no assurance that two collections bearing the same number had the same origin. The spots on two leaves in the same package or even two spots on one leaf may have originated from two different teleutospore forms, one from the caulicolous, the other from the foliicolous form. This question can be attacked to greater advantage when a more extended opportunity has been afforded for a comparison of the various stages in their development, side by side on the same plant, of these two aecidia grown under controlled conditions. There are, however, certain hypotheses that may well be stated here with considerations *pro* and *con*.

It is possible that *G. fraternum* and *G. biseptatum* are two distinct species, as it happens, having on *Amelanchier* aecidia much alike. The following points support such a view: (1) the absence

of spores with more than two cells in the sori of *G. fraternum*, and the overwhelming predominance of three- to six-celled spores in *G. biseptatum;* (2) leaves of certain marked cedar trees at Newfield, to my knowledge, have borne sori of *G. fraternum* in the spring season of three years, the first being in 1911, with no indication of there being in the process of formation the fusiform swellings characteristic of *G. biseptatum* on any of the branches in 1913–1915; (3) it is possible to infect both *Aronia* and *Amelanchier* with *G. fraternum*, while *G. biseptatum* regularly infects *Amelanchier* only, so far as known at present; (4) we may have here a case similar to that described by Long (11). The two rusts, *Puccinia Ellisiana* and *P. Andropogonis* have the common teleutospore host *Andropogon*. The aecidial stage of the former is found on *Viola*, that of the latter on *Pentstemon*. Starting with aecidiospores on the violet and going back through the *Andropogon* he is able to infect *Pentstemon* very easily; but when he begins with *P. Andropogonis* on *Pentstemon* he finds that it is much more difficult to infect the violet. He believes that *P. Ellisiana* is continually passing over from the violet through *Andropogon* to *Pentstemon* by natural infections, in which case *P. Andropogonis* is being created over and over again. Once on the *Pentstemon* the rust is probably unable to get back in nature to the violet and therefore becomes fixed as a new form of the old species, *P. Ellisiana*. In addition to the marked changes in the aecidium which I have previously mentioned, Long also finds that the uredospore characters are modified by changing the regular sequence of hosts. *Gymnosporangium fraternum* being able to infect both *Aronia* and *Amelanchier* would correspond to *Puccinia Ellisiana; G. biseptatum*, so far as known being confined to the aecidial host *Amelanchier*, is the new form. In other words, the changes wrought in the morphological characters of *G. fraternum* during its life on *Amelanchier* would be reflected as physiological changes to such an extent that the fungus on going back to the *Chamaecyparis* becomes perennial in the tissues of the branches where further morphological changes are induced. (5) Cedars inoculated by me with aecidiospores of *Roestelia transformans* in July developed sori of *G. fraternum* the following spring, while controls (not inoculated) did not. Dr. E. W. Olive transplanted a small cedar from Newfield to the

grounds of the Brooklyn Botanic Garden April 19, 1914. This cedar bore a witch's-broom of *G. Ellisii* and many leaves showed sori of *G. fraternum*. Dr. Olive has informed me that although sori of *G. Ellisii* have appeared this spring, no *G. fraternum* has been found. This, so far as it goes, suggests that *G. fraternum* is annual.

Against the first of these arguments we have Farlow's statement that the number of cells in the spores of *G. biseptatum* varies according to the size of the branches upon which sori develop—the smaller the branches the greater the number of two-celled spores.

As for the second point it should be remembered that only two converse infections have been reported in connection with this genus. Arthur (1) reports that it requires only one year to complete the development of *G. clavipes* on the common juniper. Plowright (17) shows that *G. clavariaeforme* needs two years. These authors do not state the length of time previous to these experiments the junipers had been under observation so as to preclude the possibility of natural infections. To cite a case in point: a seedling *Chamaecyparis* about four inches high bearing a dozen sori of *G. Ellisii* was brought in from Newfield in May. A month later it was difficult to locate with certainty the region infected. Heald (7) was unable to infect the red cedar with the common apple rust. It is plainly as yet entirely uncertain how long a time elapses between inoculation and the formation of the spindle-formed distortions by *G. biseptatum*.

The behavior of known biological species of other rusts is such as might account for the difference in the susceptibility of *Aronia* and *Amelanchier* to infection by *G. fraternum* and *G. biseptatum*.

Having determined the facts regarding the infection limits of *G. fraternum* and *G. biseptatum* in connection with *Aronia* and *Amelanchier*, the most difficult part of the work still remains to be accomplished if a relationship between the two species of rust is to be established. We must know, first, whether "*G. fraternum* on *Amelanchier*" (*Roestelia transformans?* on *Amelanchier*) goes back to the cedar as *G. fraternum* or as *G. biseptatum* or as both; second, does *G. biseptatum* on *Amelanchier* (*Roestelia Botryapites* on *Amelanchier*) go back to the cedar and reappear as *G. bisepta-*

tum or as *G. fraternum*, or as both. We must also have further confirmation of the experiments recorded above in connection with converse inoculations of the cedar with *G. fraternum* on *Aronia* (*Roestelia transformans* on *Aronia*). Experiments bearing on these points are under way.

COLUMBIA UNIVERSITY,
DEPARTMENT OF BOTANY

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Explanation of plates 28 and 29

FIGS. 1, 3, 13–19, 22–25 from microphotographs taken with a binocular microscope camera, magnifications given under each explanation.

FIGS. 2, 4–12, 20 and 21 from photographs, natural size. FIGS. 26–43 from drawings made with aid of camera lucida, and magnified about 400 diameters.

PLATE 28. *Gymnosporangium fraternum* on *Aronia*, *Amelanchier*, and *Chamaecyparis*

FIG. 1. Sorus on leaf of *Chamaecyparis thyoides;* photographed April 16. × 5.

FIG. 2. Two sori in swollen condition, spores germinating June 3, nearly two months after leaves were collected and dried. Natural size.

FIG. 3. Small leaf of *Aronia nigra* showing group of spermogonia. × 3.

FIGS. 4–6. A leaf of *Aronia arbutifolia* from No. 203*b* (see Table I) showing various stages in the development of basal hypertrophies, horn-like galls, and aecidia. Fig. 4 photographed May 27; Fig. 5 same leaf June 5 with full grown galls; Fig. 6 side view of the same leaf June 20. Natural size.

FIG. 7. Growing point of twig of *Aronia nigra* one month after inoculation. Photographed May 22. Natural size.

FIG. 8. The same twig July 22. The leaves on the lower part of this twig had fallen off early in June, but the gall remained dark green until killed by insects. Natural size.

FIG. 9. Twig of *Aronia nigra* with large gall which later bore many aecidia. June 15. Natural size.

FIG. 10. Leaf of *Aronia nigra* much transformed; basal hypertrophies not noticeable. Natural size.

FIG. 11. Small leaf of *Aronia arbutifolia* infected at both edges; aecidia matured June 24. Natural size.

FIG. 12. Small leaf of *Aronia nigra* not distorted by the fungus. Natural size.

FIG. 13. Tip end of leaf of *Aronia arbutifolia* bearing several horn-like galls. × 3. Compare with FIG. 22, the same fungus on *Amelanchier intermedia*, which is also magnified three times.

FIGS. 14–19. Stages in the growth and dehiscence of a peridium; FIG. 14 the peridium just appearing, very sharp pointed; FIG. 15 the same four days later showing that dehiscence begins at a point considerably below the apex; FIG. 16 the dehiscence is complete, but the apical portion is still intact; FIG. 17 another aecidium from which the apical portion, shown in FIG. 19 has just fallen off naturally; FIG. 18 a long peridium from *Aronia nigra*. × 7.

FIG. 20. Leaf of *Amelanchier intermedia* showing typical appearance of clusters of wart-like galls, slightly pitted at this stage. Compare with FIGS. 4 to 13 of the same fungus on *Aronia*. Natural size.

FIG. 21. Leaf of *Amelanchier intermedia*, galls further advanced and nearly full grown. Slightly reduced in size.

FIG. 22. Portion of the same leaf two weeks later, showing the characteristic knob at the end of each gall; one peridium well out. × 3. Compare with FIG. 13. × 3.

FIG. 23. One gall from the leaf shown in FIG. 21. The knob at the end of the gall is better shown in FIG. 25. × 7.

FIG. 24. Gall with aecidium from leaf of *Amelanchier intermedia;* the lacerations are plainly visible although the peridium has just begun to appear; spores have already been shed in considerable numbers. × 7.

FIG. 25. Gall from leaf shown in FIG. 21; the striations on the peculiar growth at the apex of the gall are visible. Compare with FIGS. 13 to 18 which show that no such structure is formed when the fungus is on *Aronia*. × 10.

PLATE 29. *Gymnosporangium fraternum*, except FIGS. 31 and 32. Magnified 400 diameters

FIGS. 26–30. Teleutospores of *Gymnosporangium fraternum;* Fig. 26, the pedicel is much swollen and the collar is distinctly visible; FIG. 27 shows that the germ pore may be at the apex of the upper cell; FIG. 28 germ pores near the septum.

FIGS. 31, 32. Two-celled teleutospores of *G. biseptatum*.

FIGS. 33–38. Various stages in the germination of spores and formation of promycelium and sporidia of *G. fraternum*.

FIGS. 39, 40. Germination of sporidia and formation of secondary spores.

FIG. 41. A peridial cell from *G. fraternum* (*Roestelia transformans*) on *Aronia*.

FIG. 42. Spore from the same aecidium.

FIG. 43. A peridial cell from *G. fraternum* on *Amelanchier*.

INDEX TO AMERICAN BOTANICAL LITERATURE

1912–1915

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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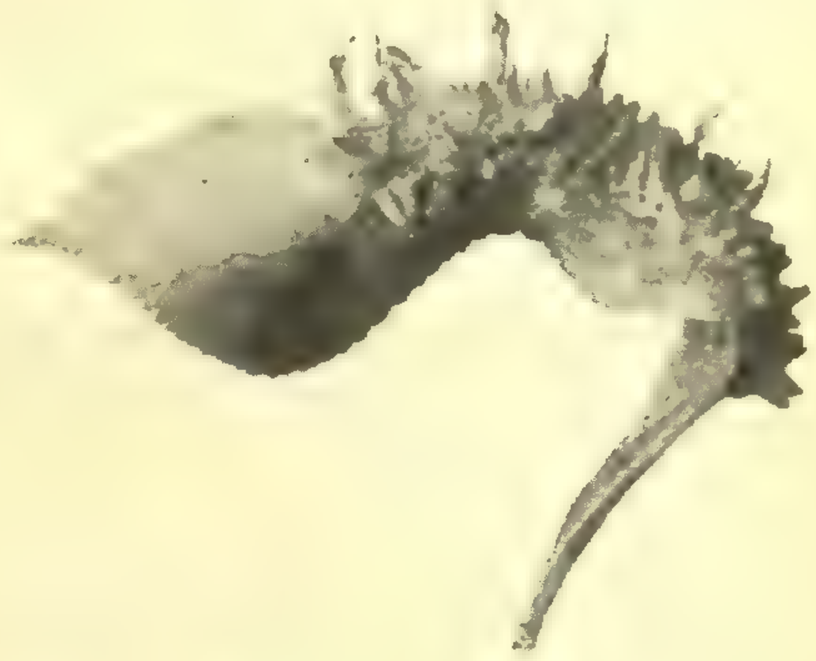

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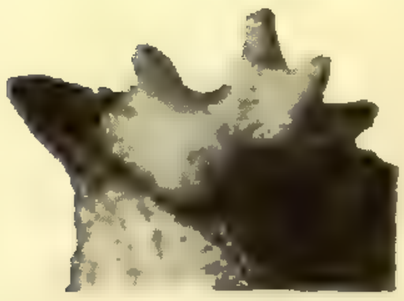

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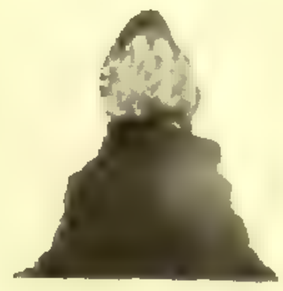

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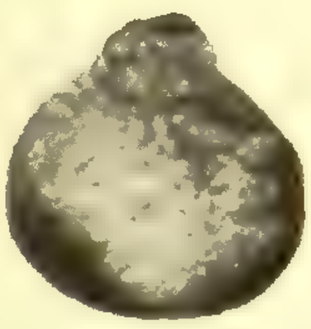

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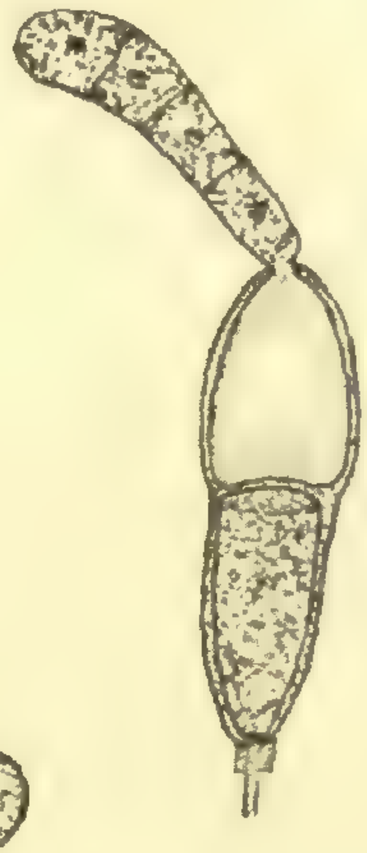

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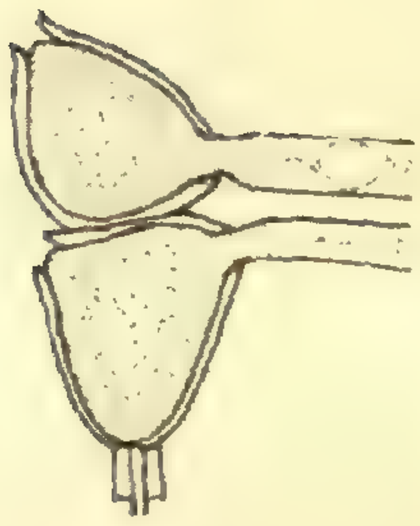

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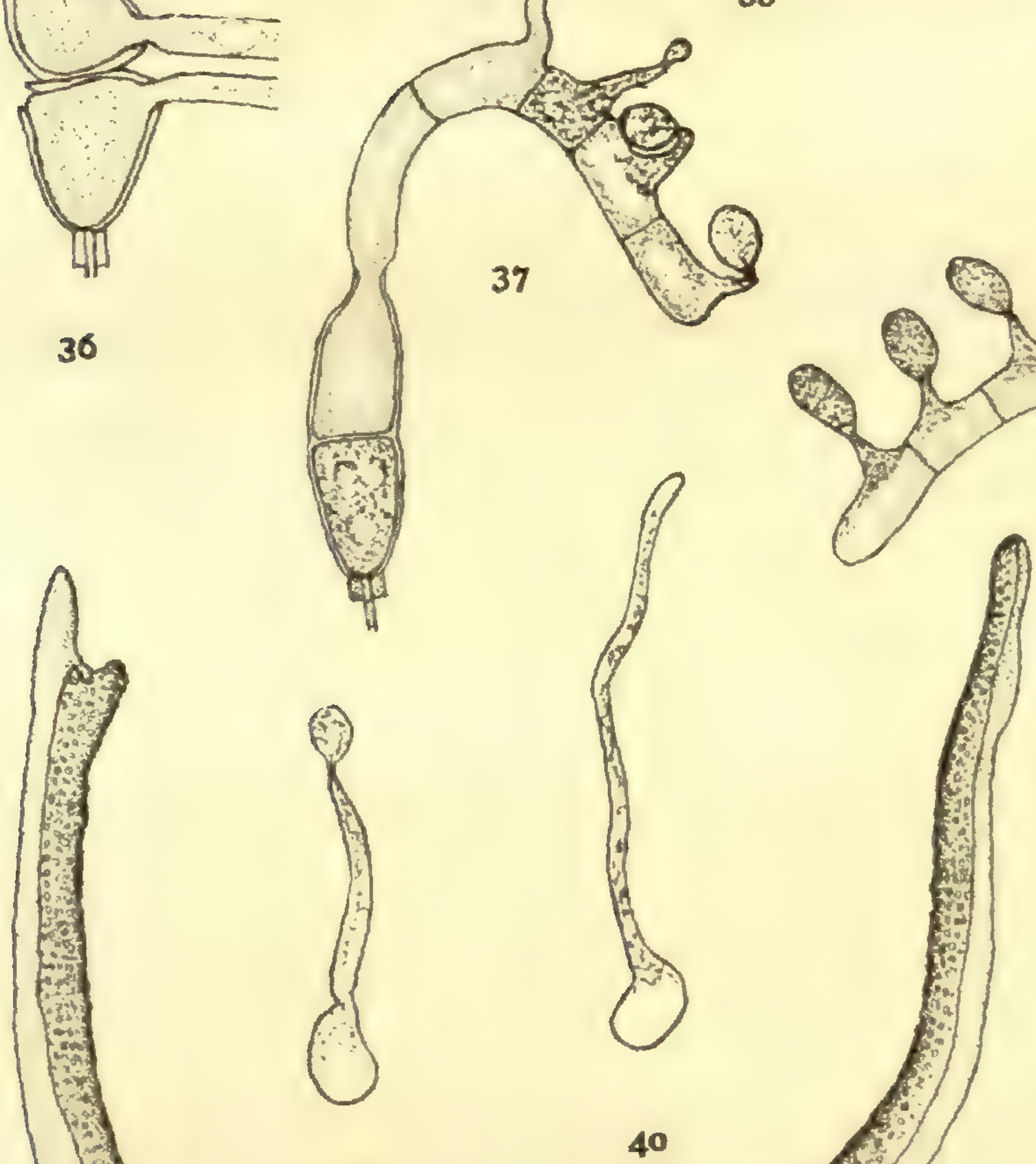

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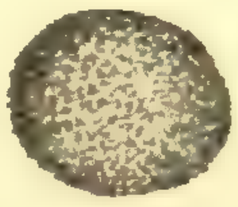

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DODGE GYMNOSPORANGIUM

Vol. 42 No. 10

BULLETIN

OF THE

TORREY BOTANICAL CLUB

OCTOBER, 1915

The ferns and flowering plants of Nantucket—XVI

EUGENE P. BICKNELL

CICHORIACEAE

CICHORIUM INTYBUS L.

In fields and by roadsides, not very common; most frequent in the neighborhood of the town. Twenty-seven years ago Mrs. Owen, writing of the chicory as a roadside plant along the south end of Orange Street, said that it had been known there for fifty years. It has remained established there to this day. First flowers July 3, 1912; continues in bloom nearly or quite through September.

KRIGIA VIRGINICA (L.) Willd.

Dry open places throughout, sometimes in white sand on dunes and wastes. Just in flower May 30, 1909; in full flower May 30, 1908; still in bloom July 4, 1912; a few remaining flowers August 6, 1906.

* HYPOCHAERIS RADICATA L.

Several clusters, in early bloom July 18, 1910, among the ruins of a house foundation on "the Cliff." Collected in 1898 by Warren H. Manning below "the Cliff," "where it seemed to be well established" (F. G. Floyd).

APARGIA AUTUMNALIS (L.) Hoffm.

Abundant and, when in full bloom, brightly conspicuous in low fields and grassy places everywhere in the town region and

[The BULLETIN for September (42: 487–548. *pl. 28, 29*) was issued November 5, 1915.]

elsewhere over the island. First flowers May 30, 1909, June 3, 1911, June 7, 1908, June 15, 1910, continuing in bloom through September.

Much of the fall dandelion of Nantucket is the var. *pratensis* Koch, which, in its most strongly developed form having large flowers with nigrescent-lanate involucres, appears quite like a distinct species. Notwithstanding its abundance on Nantucket, *Apargia autumnalis* is a very scarce plant on Martha's Vineyard, occurring only sparingly at a few far separated stations. The var. *pratensis* seems to have made its appearance only on a few lawns at Oak Bluffs and Vineyard Haven not far from where the Nantucket boats make their landings.

* TRAGOPOGON PRATENSIS L.

Established in grassy lots on Main Street and on Milk Street straying out along the thoroughfares. Collected by Mrs. Flynn in 1895. First flowers June 3, 1909; still some flowers July 6, 1912.

LEONTODON TARAXACUM L.

Taraxacum officinale Weber.

Taraxacum Dens-leonis Desf.

Apparently not a very common plant on Nantucket, and certainly not there the abundant weed we are ordinarily accustomed to regard it. Observed in flower from May until September.

* LEONTODON ERYTHROSPERMUM (Andrz.) Britton.

Taraxacum erythrospermum Andrz.

Frequent about the streets of the town; roadside at Island Home and near the Polpis school house; thicket in Shawkemo; Sankaty Light. In full flower and with mature heads May 30, 1909. Collected by Judge J. R. Churchill in 1904 (F. G. Floyd).

* SONCHUS ARVENSIS L.

Established in lots along Easton Street and nearby localities on the north side of the town. Collected by Mrs. Flynn south of the town in 1904. Freshly in bloom July 4, 1912; in full flower September 10, 1909.

SONCHUS OLERACEUS L.

A frequent weed of waste and of cultivated ground in and near the town and occasional elsewhere. First flowers June 12, 1909;

in early flower June 14, 1908, June 19, 1910, June 28, 1912; continues to bloom until late in September.

SONCHUS ASPER (L.) Hill.

Less often seen in the town than at far outlying points, mainly along shores. First flowers July 12, 1909; in full flower July 13, 1912; blooms until late in September.

* LACTUCA VIROSA L.

Farm yard in Madequet, September 14, 1907, a colony of about two dozen plants of vigorous growth but bearing no flowers. At this station on July 10, 1912, only a few plants were to be found. The plant was the common one having unlobed denticulate leaves as distinguished from the pinnatifid-leaved *L. Scariola* L.

LACTUCA HIRSUTA Muhl.

Mainly on the hills and open slopes on the eastern side of the island, the plants usually solitary or so widely separated in their association as to appear so. Frequent in Shawkemo Hills and Saul's Hills, Polpis, Siasconset, South Pasture; rare on the western side of the island. In full flower August 7, 1906; some plants continuing to bloom after the middle of September.

LACTUCA CANADENSIS L.

Scattered widely over the island in dry, open places, sometimes growing in pure sand with *Ammophila arenaria*, the plants usually solitary or not more than a few together. Often reduced in size and with numerous crowded leaves, only the lower ones spreading and pinnatifid, those above much narrowed and entire and tending to be subappressed. Blooms from midsummer until after the middle of September.

* LACTUCA SPICATA (Lam.) Hitchc.

Damp thickets along the Wauwinet road at Shawkemo and Quaise. There it is rather common but elsewhere it was seen only by an old storehouse near the wharves, a single very tall plant, in 1906. In full flower September 5, 1904.

HIERACIUM CANADENSE Michx.

Nowhere common but scattered widely over the downs and

commons, mostly single plants or a few together. Plants one foot high June 29, 1912; not in flower up to August 16, 1906; in full flower early in September, continuing in bloom through the month.

HIERACIUM GRONOVII L.

Very common in dry open places throughout, flowering in August and September.

Note—Hieracium scabrum Michx. occurs on Martha's Vineyard and on Chappaquiddick Island and may yet be found on Nantucket.

* HIERACIUM AURANTIACUM L.

In June, 1909, Mrs. Mary A. Albertson showed me fresh flowering specimens of the orange hawkweed that had been brought in to the rooms of the Maria Mitchell Association, having been gathered back of the dunes near the bathing beach.

HIERACIUM MARIANUM Willd.

Not anywhere growing in close formations but scattered openly everywhere over the plains and commons this is one of Nantucket's characteristic plants. It blooms from early June through September, and doubtless, as on Martha's Vineyard, well into October; but autumn flowering seems to come about as a sort of second flowering period, for there is a late summer interval when the species passes nearly or quite out of bloom. Earliest leaves appearing May 30, 1909; first flowers June 8, 1908, June 12, 1909, June 15, 1910.

On Nantucket this species displays a ready variability deviating from its proper type into perplexing forms that appear to be more or less intermediate with *Hieracium venosum* L., or even scarcely to be distinguished from that species. Some examples, indeed, might readily pass without question for *H. venosum*, but I have not yet seen any Nantucket specimen that I could feel satisfied should bear that determination. On the other hand frequent examples match quite perfectly those more pronounced forms of *H. marianum* that develop a stout papillose-hirsute stem, leafy up to the firmly branched panicle. But the prevailing Nantucket plant is less coarsely pubescent and has the larger cauline leaves reduced in number to one or two only, low on the stem, and a

more open, even diffuse, corymbiform inflorescence. In hard shallow soils the basal leaves are relatively short and broad and are clustered in a flattened rosulate tuft after the manner of *H. venosum*, and may be either purple-venose as in that species or wholly green. In deeper and looser soils these lower leaves are more ascending on longer petioles and are often narrowly oblanceolate and tapering acute, a few of the outermost sometimes purple-veined; those that appear earliest are almost always papillose-pilose on the upper surface. The longer pubescence at the base of the leaves and stem varies from white-pilose to coarsely papillose-hirsute with tawny hairs and, in leafy forms, may extend well up on the stem which, also, with rare exceptions, is invested throughout with a minute floccose or tomentulose canescence that passes up through the entire panicle. This canescence of the panicle, together with the very glandular, pubescent and nigrescent involucre, appears to be a character worthy of primary consideration in the determination of ambiguous examples.

The apparent absence from Nantucket of typical *H. venosum*, while yet its influence would seem to be discernible there in the unstable phases of *H. marianum*, offers the suggestion that *H. venosum* may have once belonged to the island's flora. The course of its subsequent history there may then well have been that, having lost the protection of its original woodland it had been unable to hold its proper identity against the competition and possible interbreeding of a closely related and more dominant species.

* NABALUS SERPENTARIUS (Pursh) Hook.

Confined almost exclusively to the open plains on the south side of the island, and uncommon except in the southwest quarter; two small plants seen in Saul's Hills. Just in flower September 14, 1899. Often dwarfed, with simple stem and terminal inflorescence, the smaller plants only 2–3 dm. high and the cauline leaves 2–3 cm. long. Stouter plants become widely bushy branched and very floriferous but are never very tall.

NABALUS TRIFOLIOLATUS Cass.

Not uncommon on the eastern side of the island in thickets and open ground, especially in the southeast quarter. On the plains

east of the middle of the island it almost entirely replaces *N. serpentarius* of the western side, the two species rarely being found near together. In full flower August 30, 1904; continues in bloom through September.

On the exposed plains this species becomes even more dwarfed than the preceding, sometimes not exceeding 1.5 dm. in height when fully mature. This open ground form displays much purplish coloration which deepens to blackish purple in the upper parts and the involucres in marked contrast with the clear white rays. Its leaves are firm and unusually small, with their narrow deeply parted divisions and lobes cuspidate-acute; the bracts of the involucre are usually narrowly attenuate. A markedly contrasting form found in shaded thickets is taller and slenderly branched, little if at all purplish tinged, and with more ample and thinner leaves, except the lowermost often nearly entire or merely hastate lobed; the involucral bracts are commonly shorter and less tapering than in the contrasted form and the rays yellowish instead of clear white.

AMBROSIACEAE

* IVA OVARIA Bartlett.

Iva frutescens auct. non L.

This characteristic salt marsh plant, here close to the northern limit of its range, I have seen nowhere else on Nantucket than near the harbor shore about Acquidness and Abram's Points where it thrives by the tide pools and along the marshes. Just in flower September 3, 1904.

* IVA XANTHIIFOLIA Nutt.

A single large plant in flower and fruit near the wharves September 15, 1904. A vigorous group on Howard Street, July 12, 1912, the tallest plants four feet high and the inflorescence just beginning to appear. This same colony had been observed by Mrs. Flynn August 17, 1911, and was also discovered by Miss Grace Brown Gardner, who has sent me fruiting specimens collected September 1, 1913.

The plants from these two stations seem to represent two rather distinct forms of the species, one having leaves triangular-

ovate and harshly papillate-pubescent, the other possessing a much finer and closer, even a soft, canescent pubescence, and more or less cordate leaves. In the latter, the Howard Street plant, the larger leaves were deeply cleft into three, or even five, broad overlapping lobes, these also deeply lobed and cut; the largest leaves were over 2 dm. in length and breadth, their primary divisions over 12 cm. wide.

* AMBROSIA TRIFIDA L.

A few rather low plants, with unlobed leaves, in waste spot west of the town, August 11, 1906, in full flower; young plants mostly under 15 cm. high, with deeply three- to five-lobed leaves, in a farm yard in Polpis, June 12, 1911.

AMBROSIA ARTEMISIAEFOLIA L.

An abundant weed flowering from late summer doubtless until killed by frost. Represented by several varieties or elementary species differing in leaf pattern and pubescence.

* AMBROSIA PSILOSTACHYA DC.

Mrs. Flynn has kindly sent me for examination specimens of this species in full flower and fruit collected by her near Sankaty Head, August 13, 1897. Dr. Rydberg has examined these specimens with me at the herbarium of the New York Botanical Garden. They are perfectly typical and are closely matched by numerous examples from the far west. I do not know that this species has ever been recorded from east of Illinois other than as a ballast plant, but it seems quite possible that it may have been making its way eastward unnoticed through its similarity to *A. artemisiaefolia*. Its presence on Nantucket in a part of the island where unusual introduced plants would scarcely be looked for is not suggestive that it is a wholly exceptional waif in our eastern flora. It is in point that it occurs also on Martha's Vineyard, where I found it along a weedy roadway at Edgartown in full flower September 14, 1910, and in mature fruit October 12, 1911. The only other eastern specimen of wich I have any knowledge is one in the herbarium of the New York Botanical Garden collected on ballast ground at Weehawken, New Jersey, September 6, 1895. But as far back as 1888 the species was included among the ballast plants found in the vicinity of New

York and Philadelphia, which was published in the "Preliminary Catalogue of plants within one hundred miles of New York City," compiled by a committee of the Torrey Botanical Club.

XANTHIUM ECHINATUM Murr.

Primarily a plant of the sea beaches, but not infrequent in waste places away from the shore. It thrives best where saline influences are strongest, and on the exposed ocean front becomes larger and coarser as well as paler in color than when growing along bays and estuaries, and at interior stations where it has chanced to spring up. Seedlings, May 30, 1909, unfolding their first leaves between the large spreading cotyledons; plants very small July 3, 1911; in full flower and fruit through September.

COMPOSITAE

* EUPATORIUM MACULATUM L.

Rare; in "the Woods" several small scattered groups were just in bloom September 8, 1904; elsewhere it was seen only in a boggy spot east of Miacomet Pond, a single cluster.

* EUPATORIUM PURPUREUM L.

At one station only, and only a single group of plants. These grew on a bank in a low open thicket in Shawkemo, towards Quaise, the tallest plants nearly six feet high. When first seen, September 11, 1907, most of the stems had been trampled down by cattle and none had flowered. On June 7, 1908, they were growing up again, the larger stems being eighteen inches high. The plant is typical of *E. purpureum* as distinguished from *E. trifoliatum* L.

EUPATORIUM PERFOLIATUM L.

Abundant in low grounds. In August and September when the waters of the island are low the boneset may be seen in full flower fringing the high water line around many a pond and pool then well back from the water's edge, its masses of bloom sometimes forming an unbroken zone of white around the sandy shores. Evidently its seeds are carried by the wind to the surface of the ponds at the season of high water and are floated in numbers to the shore, finding protection in the flotsam there and a favorable medium for their germination the following season.

EUPATORIUM VERBENAEFOLIUM Michx.

Common in low grounds, often about thickets and among open growths of shrubbery. Flower buds visible July 4, 1912; in full flower August 7, 1906; blooming through September. The Nantucket plant, although often quite typical, is mainly the form with narrowed deeply incised leaves—var. *Saundersii* Porter.

EUPATORIUM PUBESCENS Muhl.

A single cluster in full flower August 16, 1906, at the border of a low thicket in Quaise. Collected on Nantucket twenty-three years earlier, August 18, 1883, by Judge J. R. Churchill. Judge Churchill has most kindly sent me for examination his specimen collected at that time, which is of particular interest as having been the basis of Mrs. Owen's record of *Eupatorium rotundifolium* on Nantucket. It is one of those troublesome forms that seem to lie midway between typical examples of *E. rotundifolium* and *E. pubescens*, and is very similar to my own Nantucket specimens which, after careful study, I do not doubt are properly referable to *E. pubescens*. Judge Churchill's specimen is a stout and large-leaved plant, the leaves reaching a size of 5–6 cm. in length by 4–5 cm. in breadth. As is the case with my own more slender and smaller-leaved specimens the number of flowers in the heads is mostly seven.

* EUPATORIUM HYSSOPIFOLIUM L.

Dry open ground near Sachacha Pond, on the southwest side, a considerable colony just in bloom August 13, 1906; Spotsor Country, several scattered stations; two small plants below "the Cliff," 1907; Pocomo, in full flower September 21, 1907.

* EUPATORIUM AROMATICUM L.

About dry thickets and in neighboring open ground, local. Quaise; Polpis, at several stations, and in abundance at one locality near Almanac Pond; by the railroad near the fifth mile post; Siasconset. In full flower August 31, 1904, September 19, 1907. Collected by Mr. Floyd near Tom Never's Head in 1902.

* MIKANIA SCANDENS (L.) Willd.

Wet thicket along Watt's Run where it twines in luxuriant growth among the shrubbery and in late August and in September

is conspicuous from its profuse bloom. "Gibb's Swamp, one plant, 1895, L. L. Dame" (F. G. Floyd).

LACINARIA SCARIOSA (L.) Hill.

A characteristic and attractive late flowering plant of the downs and moorland. It is found throughout the length of the island but, except locally, seems to be common only on the eastern side, more especially towards the southeast. It is scarce in the immediate vicinity of the town although frequent westward towards the waterworks; eastward it is scarcely to be found nearer than Shawkemo, and still further east and northeast it is scarce except in Pocomo; southeast of the town it first appears about two miles out near the railroad and south of the County Fair grounds, extending thence into Saul's Hills and southeast to the ocean shore where it may be seen flourishing in the wastes of white sand through which the railroad approaches Siasconset. It occurs in Madequet but seems to be wanting over most of the western half of the island. Widely variable. Plants a few inches high July 11, 1912; a few early flowers August 6, 1906; continues in bloom through September. One plant with white flowers, Almanac Pond, 1902 (F. G. Floyd). It is a common plant of Chappaquiddick Island, but I have not seen it elsewhere on Martha's Vineyard.

CHRYSOPSIS FALCATA (Pursh) Ell.

The golden aster is one of the very abundant plants of Nantucket, perhaps even more numerous than the bearberry, probably because less fastidious in its choice of soils, and spread far and wide over fields and plains where the bearberry has not made its way. Throughout the length and breadth of the island it is at home everywhere in dry sandy exposures where other vegetation is low and scant, even on the dunes and wastes of white sand where the beach grass may be the only other living thing. A precocious flower June 27, 1910; two open flowers July 8, 1912, flowers at several places the following day, quite generally in bloom two days later. Continues to bloom into October.

SOLIDAGO CAESIA L.

This golden-rod is among those named in Mrs. Owen's list. It is common on Martha's Vineyard and I have always expected

to come upon it somewhere on Nantucket but have never yet met with it there.

* SOLIDAGO BICOLOR L.

Found only on the eastern side of the island, mainly in the southeast quarter in the neighborhood of the railroad and scattered sparingly towards Saul's Hills; also near Sachacha Pond and Wauwinet. Just in flower September 1, 1904.

Although rather a scarce species on Nantucket it is there subject to as notable a degree of variation in leaf form and pubescence as is seen in regions where it grows in abundance. But beyond these usual variations are the more divergent characters of a form that I have seen nowhere else than on Nantucket. This is characterized by a pale or whitened appearance throughout due to a hoary-tomentulose canescence that invests the stem and branches and develops on both surfaces of the leaves into a soft tomentose or velutinous indument; and it is further noteworthy in its inflorescence which is borne at the ends of slender terminal branches that are closely set with small leaves of nearly uniform size; the flowers are small, their involucres only 2–3 mm. high, and the green tips of the scales, often so obvious in this species, are only faintly if at all perceptible. This variety appears to occur only on the open plains and scrub oak barrens in the southeastern quarter of the island.

SOLIDAGO PUBERULA Nutt.

A common golden-rod of the moorland and oak barrens and of open sandy places in certain soils. It is perhaps more abundant in the southwest and the northwest quarters than elsewhere, and is quite wanting in many parts of the island where the conditions do not differ obviously from those of the sections where it abounds. Just in bloom September 14, 1907. The panicle varies in form from virgate and only 2 cm. wide to oblong-pyramidal and more than 12 cm. in natural spread at its widest part.

SOLIDAGO ODORA Ait.

Rather common, although somewhat locally distributed, preferring open growths of low shrubbery in light sandy soil. Not in flower up to mid-August, 1906; mostly past flowering September 19, 1907.

SOLIDAGO SEMPERVIRENS L.

Along all the sea beaches and salt marshes, sometimes inland in dry sandy spots or in low grounds. A precocious spray in full bloom June 22, 1910; not nearly in flower up to August 16, 1906; blooming till late autumn.

SOLIDAGO RUGOSA Mill.

Frequent or rather common mainly on the eastern side of the island in or about low grounds. First flowers September 2, 1904, September 7, 1906.

A low villous form found in Polpis had small and narrow almost leafless panicles and numerous crowded leaves smooth or nearly so on the upper surface, the narrowly cut teeth with subcartilaginous tips, many of them firmly declined and even reflexed.

* SOLIDAGO RUGOSA × SEMPERVIRENS.

S. asperula Desf.

On a bank at the southwest side of Capaum Pond, several clusters in full flower September 12, 1907, growing with both *S. rugosa* and *S. sempervirens*. A distinct appearing and not rare seaboard golden-rod occurring sporadically and always, so far as I have observed it, in association with both of its reputed parents.

It is interesting, in view of the scarcely to be doubted hybrid character of this plant, that the most considerable colony I ever met with was in full bloom while yet its supposed parents growing close about it showed not an open flower. This was near Long Beach, Lond Island, September 5, 1909; on that day a few precocious flowers of *S. sempervirens* were seen at places favorable to early flowering, but *S. rugosa* was not anywhere nearly in bloom.

* SOLIDAGO ASPERA Ait.

Common, mainly along the borders of thickets and on dryish levels in low grounds. Not yet in flower up to August 16, 1906, just in bloom September 2, 1904.

A little recognized and widely variable golden-rod, not ordinarily to be confused with *S. rugosa*, but often associated with it and quite probably subject to intercrossing.

*** Solidago aestivalis** sp. nov.

A common Nantucket golden-rod of low grounds and boggy places, closely related to *S. rugosa*, but having a much earlier flowering period, and notable as the earliest flowering golden-rod of the island. In full flower August 4, 1906; passing out of bloom September 2, 1904, when the earliest flowers of *S. rugosa* were only beginning to appear; mostly past flowering and many panicles dried and brown September 1, 1907. Common also on Martha's Vineyard and on Lond Island and occurring on Staten Island.

Commonly from 8–12 dm. high (2–20 dm.), the stem strongly striate-angled, especially above, glabrous and shining or occasionally with some scattered hairs, typically deep or even bright purple throughout including the branches of the panicle; leaves deep green, numerous, the larger 6–14 cm. long and 2–3 cm. wide, elliptic-lanceolate, attenuate or acuminate, often abrupt y rounded at the extreme base, the lowermost narrowed into rather long, margined petioles; blades not ordinarily rugose nor prominently venulose, appressed-serrate or, in one form, openly cut-serrate, the upper surface often lustrous, smooth and glabrous or with some scant obscure hairs, thinly pubescent with loose tapering hairs on the veins beneath, the narrower lower leaves sometimes finely close pubescent, their margined petioles ciliate; branches of the inflorescence angled and thinly villous-pubescent; inflorescence commonly of wide spreading and recurved foliaceous branches forming a broad open panicle, or the panicle sometimes elongated and short branched; heads numerous and crowded, secund in paniculate leafy-bracted racemes and short ultimate clusters; involucre 2.5 to 3.5 mm. long, its bracts linear-oblong to linear, obtuse, mostly ciliolate, subcarinate, firm, broader and less tapering than those of *S. rugosa* and not recurving in age, the prominent midrib mostly broadened into the greenish tip; rays commonly eight (6–12), the heads spreading 4–5 mm.; achene pubescent.

Type from Hewlett, Long Island, August 9, 1914, deposited in the herbarium of the New York Botanical Garden.

In the coastwise swamps of southern Long Island this golden-rod comes into bloom from the middle of July until early in August, three to five weeks in advance of *S. rugosa* and much of it is past flowering at the time the latter begins to bloom. The close relationship of *S. aestivalis* to *S. rugosa* is evident enough, and examples are not wanting that suggest either that the two are

sometimes intergradient or that they occasionally hybridize. Nevertheless it would be little doubted, I think, by anyone coming to know *S. aestivalis*, that it was essentially distinct, and long ago it became to me an authentic and, from its early time of flowering, a particularly interesting member of the golden-rod group. Its smooth and purple striate-angled stem is notably at contrast with the more terete and papillate-hirsute or villous stem of normal *S. rugosa*, although its smoothness may not be taken as a strictly determining character, for *S. rugosa* occasionally passes into glabrate forms; but such divergent plants, as I have met with them on Long Island, are obviously only local variations from the type not at all to be correlated with the normally glabrous stemmed *S. aestivalis*. In view of such variations, however, the characters of the latter might be given less weight did not its definitely earlier flowering period, both in its beginning and ending, imply a very pronounced remove from identity with the broadly similar *S. rugosa*.

SOLIDAGO ELLIOTTII T. & G.

Common in low grounds. Some flowering panicles September 10, 1907, but not yet generally in bloom at that time.

SOLIDAGO UNILIGULATA (DC.) Porter.

Not infrequent in *Sphagnum* bogs on the eastern side of the island. Not in flower up to the middle of August, 1906; in full bloom September 5, 1904.

Note.—Solidago neglecta T. & G. is named among the golden-rods of Mrs. Owen's catalogue, and it may well be a rare plant of Nantucket, but no evidence appears that it has ever been collected there. It is quite possible to mistake for it large examples of *S. uniligulata* or even forms of *S. Elliottii*.

* SOLIDAGO JUNCEA Ait.

This common eastern golden-rod seems to be all but absent from Nantucket, only a solitary cluster having been discovered there. This grew on a dry slope near the Wauwinet road about half a mile west of Pulling Mill Creek. On August 16, 1906, its several vigorous stems bore panicles of close green buds, and on September 11, 1907, it was in full bloom. The plant was perfectly

typical of the ordinary glabrous open ground form of the species, and this is to be particularly noted for a very interesting reason: all over Chappaquiddick Island grows the similar plant known as var. *scabrella* Gray, not hitherto reported, I think, on our eastern seaboard. Typical *S. juncea* was not found on Chappaquiddick Island, nor did I meet with it anywhere on Martha's Vineyard.

SOLIDAGO ALTISSIMA L.

S. canadensis Auct. non L.

Common, mainly along thickets near low grounds; disposed to grow in close masses, and frequently forming a broad encircling zone of yellow around the thickety borders of pond holes. Not nearly in flower August 16, 1906; freshly in bloom August 24, 1904.

The Nantucket plant is all typical of *S. altissima* as now understood, at least I did not succeed in finding on the island a smaller-headed and less pubescent golden-rod of the same group that is common in the neighborhood of New York and which, if it be the true *S. canadensis* of Linnaeus, as would seem to be altogether probable, judging from the description in Species Plantarum, is manifestly not the same as the more northern plant now known by that name and earlier described as var. *glabrata* Porter.

SOLIDAGO NEMORALIS Ait.

The Nantucket *S. nemoralis* is a hoary-canescent, mainly depressed or prostrate form that has been characterized by Professor Burgess as var. *arenicola*. It is an abundant species, perhaps the most so of all the Nantucket golden-rods, growing everywhere on open sandy levels, so thickly in many places as to give its color conspicuously to extensive tracts that support no tall herbage, but where the golden aster and the violet-flowered *Ionactes* aster also abound. Even in its more erect states it displays a strikingly different aspect from the more usual forms of *S. nemoralis*, but it appears to possess no essential distinctive characters. On Nantucket I have seen no examples unmistakably referable to typical *S. nemoralis*, but on Martha's Vineyard the case is different. There the divergence from *S. nemoralis*, although often as great, is not at all as general, and many examples are intermediate between the two forms. The case is analogous to that of a number of other plants, that, on Nantucket, show a

greater development of pubescence and a less erect habit than their usual mainland forms. First flowers early in September, 1904; in full bloom September 10, 1907.

EUTHAMIA GRAMINIFOLIA (L.) Nutt.

Local in dry places in all quarters of the island, especially on the eastern side, but irregularly distributed and wholly wanting throughout extensive areas. Not yet in flower August 16, 1906; first flowers September 17, 1907.

EUTHAMIA TENUIFOLIA (Pursh) Greene.

In dry or in damp sandy soil, or even in heavy soil in low grounds. Perhaps the commonest and most generally distributed golden-rod of the island, unless *S. nemoralis* should bear that distinction. Just in flower August 16, 1906.

Perplexingly variable. Some coarser forms appear to be quite intermediate with *E. graminifolia*. More delicate plants formerly included with this are better referred to the following, which, however, may be viewed with some reservation as to its validity.

EUTHAMIA MINOR (Michx.) Fernald.

Common, in its extreme form appearing like a very distinct species, but apparently intergrading with the preceding.

SERICOCARPUS LINIFOLIUS (L.) B.S.P.

Widespread over the downs and commons and invading open tracts of scrub pine, growing in separate often solitary tufts of stiff clustered stems. First flowers July 11, 1912, in full flower through August; late flowers in protected places September 12, 1907.

SERICOCARPUS ASTEROIDES (L.) B.S.P.

Everywhere on the open commons and hillsides, as well as in pine woodland, growing in small colonies of separate plants. First flowers July 11, 1912; in full flower through August and continuing to bloom through most of September.

* ASTER DIVARICATUS L.

Not uncommon in Squam, and occasional in Polpis, but so closely hidden in dense thickets as to be little seen unless carefully sought for. In full flower September 17, 1907.

On Nantucket this aster seems to be not widely variable, and wherever observed, except at one station, was characteristic of typical *A. divaricatus*, as defined by Professor Burgess; specimens from a number of stations agree closely with examples so named by him in the herbarium of the New York Botanical Garden. The only marked variation observed was in a thicket in Squam where specimens, in leaf only, collected July 4, 1912, seem to show a definite approach to *Aster persaliens* Burgess (Mem. Torrey Club 13: 140. 1906).

On Chappaquiddick Island the species is less exclusively true to type and is represented by several well marked forms.

ASTER UNDULATUS L.

Nowhere in great abundance, but widely scattered over the moorland and commons, growing up into taller forms in the borders of thickets. Small green flower buds August 10, 1906; first flowers September 12, 1907. Widely variable, passing into the vars. *loriformis* and *torquatus* of Professor Burgess.

An ambiguous aster, a solitary plant of its kind, collected below "the Cliff" September 22, 1907, is linear-leaved and violet-flowered, and slightly roughish puberulent on stem and leaf. It appears to combine so unmistakably characters of *Aster undulatus* and *Aster dumosus* that there would seem to be little reason to doubt a hybrid origin from those species.

ASTER PATENS Ait.

A common dry soil aster of thickets and open ground. Often reduced in size and bearing small and much roughed leaves, and relatively small heads with deep colored rays. A single precocious flower August 16, 1906; generally just in bloom September 11, 1907.

ASTER NOVI-BELGII L.

The prevailing aster of low grounds and boggy places, widely variable and readily passing into a number of diverse forms; var. *elodes* Gray is common throughout; var. *atlanticus* Burgess, although rather scarce, is sometimes of pronounced character, the larger leaves becoming 1.5 dm. long by 3 cm. wide; other forms seem to be more or less representative of var. *littoreus*

Gray. In full flower through September; precocious flowers are frequent before the middle of August.

An aster in full flower, collected by the Wauwinet road near Norwood, is quite intermediate between this species, more especially var. *elodes*, and *Aster dumosus*, and has every appearance of being a hybrid.

ASTER CONCOLOR L.

One of the conspicuous late flowering plants of the plains and commons. It is not ordinarily densely massed in growth, but at Hummock Pond along a bank of white sand close to the ocean shore it was seen late in September outspread in an even more continuous breadth of color than a bed of violets in spring. First flowers September 8, 1904, September 15, 1907. It is also a very common aster of Chappaquiddick Island where I have seen it still in full flower as late as the middle of October.

The pubescence of the early leafy shoots is remarkably different from the canescent investiture of the mature stems consisting of silky-villous horizontally spreading hairs, some of them 4–5 mm. in length. The earlier leaves which are spreading, and densely pilose and long ciliate, are, by a twist at the base, brought into two opposite series along the stem with their surfaces in lateral aspect instead of horizontal, after the manner of *Lactuca virosa*.

ASTER SPECTABILIS Ait.

Rather common towards Siasconset in open thickets of low shrubbery in dry places; scarce in other parts of the island: Wauwinet road less than two miles from the town; near the south shore to the west of Miacomet Pond; north of Long Pond. In full flower August 30, 1904; September 11, 1907.

ASTER DUMOSUS L.

Perhaps the most common and generally distributed aster of the island, most numerous in sandy soil in low grounds. In full flower September 10, 1907. Forms having small heads with deep lavender rays contrast markedly with other forms having larger heads with the rays pure white. A form referable broadly to the var. *cordifolius* (Michx.) T. & G., yet not the same as the typical southern extreme of this plant, is occasional in pine barrens.

* ASTER VIMINEUS Lam.

In damp places in fields and open ground, rather scarce, the var. *foliolosus* Gray occasional. Just in flower September 4, 1904; not yet in bloom September 12, 1907.

* ASTER LATERIFLORUS (L.) Britton.

Frequent or rather common in thickets on the eastern side of the island. Small green flower buds August 13, 1906; just in bloom September 11, 1907.

In the ordinary shade forms the leaves may be thin and coarsely cut-serrate, becoming over 2.5 cm. broad, or narrow, and entire or nearly so. In more open thickets the plant becomes taller, sometimes 1.2 m. high, with the openly wide spreading or drooping branches 4–5 dm. long—var. *pendulus* Burgess; forms similar to this growing in sunnier places are sometimes almost grayish puberulent in their upper parts, and have linear-lanceolate and rather roughish leaves, and narrower involucral bracts than the more glabrate shade forms. Other forms agree closely with specimens labeled by Professor Burgess var. *horizontalis* (Desf.).

* ASTER MULTIFLORUS Ait.

Very common in dry fields and along roadsides as well as in the town streets. Here and there a plant showing its earliest flowers September 12, 1907. At certain localities on exposed levels near the south shore many dwarf plants grow firmly prostrate on the parched soil blooming no less profusely than the normal erect plant.

* ASTER PRINGLEI (A. Gray) Britton.

One of the surprises of Nantucket. A numerous colony established along the face of the low clayey bank back of the beach at Siasconset, south of the settlement, in full flower August 30, 1904; much of it past flowering September 15, 1907.

It was so unexpected to find this aster on the seaboard, and at the latitude of Nantucket, that I have been particular to have its identity confirmed by Professor Burgess. It is perfectly typical and closely matches authentic material from Vermont, Michigan and Wisconsin.

Note.—If *Aster ericoides* L. occurs on Nantucket it is yet to

be detected there. The absence of this common eastern species is one of the noteworthy negative features of the Nantucket flora. Its name does, indeed, appear among those of the common asters of Mrs. Owen's catalogue, but since the abundant *Aster multiflorus* is omitted it seems to be evident that the one was mistaken for the other. It occurs on Martha's Vineyard where, however, it is scarce and local.

* ASTER TENUIFOLIUS L.

Locally common in salt marshes along the harbor in the northeastern quarter of the island, growing in the black grass (*Juncus Gerardi*): Quaise, Swain's Neck, Squam, Pocomo. In early flower August 16, 1906; in full flower September 21, 1907. Observed in flower on Chappaquiddick Island as late as October 12, 1911.

ASTER SUBULATUS Michx.

One of the common plants of the salt marsh flora, mainly on mud flats and along the borders of tide pools and ditches, blooming during September. In full flower on Chappaquiddick Island as late as October 9, 1910.

IONACTIS LINARIIFOLIUS (L.) Greene.

An abundant aster of the dry sandy plains and commons. Its natural flowering season, when everywhere it reaches its height of bloom, appears not to begin much before mid-September, but precocious flowers are frequent in midsummer, and have been observed as early as July 5 (1912). First flowers early in September, 1904, September 12, 1907; generally still in full bloom on Chappaquiddick Island as late as October 11, 1908.

DOELLINGERIA HUMILIS (Willd.) Britton.

Somewhat locally rather common in low grounds across the northern side of the island, also about Siasconset. Minute flower buds July 11, 1912; not in bloom up to August 16, 1906; in full flower during September.

A striking bit of evidence of the far reach to Nantucket of a more southern flora is the replacement there of the common *Doellingeria umbellata* (Mill.) Nees, natural to the latitude, by this closely related plant that is not known elsewhere north of southern New Jersey. It matters little how close may be the relationship

of these asters, or even if they are intergradient—here on Nantucket is the plant of the New Jersey pine barrens in exact counterpart and perfectly acceptable to the eye as being not the same as its more northern relative. As compared with the latter the Nantucket plant has shorter and broader leaves of thicker texture, deeper green above and conspicuously pale beneath, harmonizing well by contrast of color with the usually deep purple stems. Although it grows to a height of 1.5 m. and has leaves as broad as 3–4 cm., there is an interesting smaller form only 5–6 dm. high with more numerous crowded leaves, 4–5 cm. long, 1.25–1.50 cm. broad. In the most typical examples the involucral bracts are broader and more obtuse than those of *D. umbellata*, and the pappus at maturity is of a bright cinnamon brown color. It is quite possible that typical *D. umbellata* grows in some of the Nantucket swamps but I have never collected it.

* ERIGERON PULCHELLUS Michx.

Not infrequent in Pocomo, especially towards Wauwinet; observed elsewhere only in Quaise, a small colony, and at the border of Tom Never's Swamp, a solitary cluster. In full flower June 9, 1909, 1911.

* ERIGERON PHILADELPHICUS L.

Several well developed plants in full flower June 22, 1910, at the border of a swamp west of Long Pond.

* ERIGERON ANNUUS (L.) Pers.

Scarce. A single flowering plant in an old field near Miacomet Pond September 21, 1899; a group in the same locality, just in bloom June 22, 1910; one plant on Lily Street August 6, 1906; well colonized in a pasture near Island Home, June, 1912.

ERIGERON RAMOSUS (Walt.) B.S.P.

Widely scattered over the downs and commons, mostly single plants of low stature; of better size and more gregarious habit in old fields and grass lands. First flowers June 18, 1908, June 25, 1910, 1912, blooming through September.

Mrs. Owen's catalogue records the occurrence of the frequent form or state of the species having the rays very short or wanting —var. *discoideus* Robbins.

LEPTILON CANADENSE (L.) Britton.

Erigeron canadense L.

A very common weed of old fields and dry open places, blooming in August and September.

* LEPTILON PUSILLUM (Nutt.) Britton.

Erigeron pusillus Nutt.

In December, 1913, it was shown by Dr. Robinson (Rhodora **15**: 205–209) that *Leptilon pusillum* was a valid species, an acute discrimination, and the plant was reported from localities in the Cape Cod region and from Martha's Vineyard, and, as these pages go to press, I am enabled to record it from Nantucket, typical examples, collected during the past season, having been sent to me by Miss Grace Brown Gardner. Miss Gardner writes me that she met with it at a number of localities, and I myself, in a very brief visit to Nantucket late in September, found it to be widely scattered there, inland as well as near the shores. It was also found to be an abundant plant of Martha's Vineyard, fully as numerous, I think, as *Leptilon canadense* and, like that familiar weed, distributed from the sandy levels along the shores to open hillsides in the interior of the island. Where it mixed freely with *L. canadense* there were not wanting examples that appeared almost to unite the two species, although no specimens were found that could not be fairly assigned to the one or the other. The purple tips of the involucral bracts which, from observations made on Long Island, I had come to look upon as an absolutely constant character, here proved to be, locally, a very unstable one. In most specimens, however, in which at first sight the purple tips seemed to be absent, it was usually possible to detect them in some of the heads, even if only on the inner bracts. Occasional specimens in which the purple tips were quite wanting showed involucres more or less purple tinged throughout. Late in the season the rays both of this species and of *L. canadense* often become pink tinged or rose color, and purple tips often appear on some of the involucral bracts of *L. canadense*.

Mosses of the Philippine and Hawaiian Islands collected by the late John B. Leiberg

R. S. Williams

PHILIPPINE SPECIES

Trematodon capillipes C. Müll. Luzon: Mariveles Mountain, *1267*.

Dicranella (*Anisothecium*) **Leibergii** sp. nov.

Growing in rather soft, not very compact, brownish green mats; stems short, 4–5 mm. long and simple or sometimes with a single branch up to 1 cm. long; leaves laxly spreading-flexuous, narrowly lanceolate, up to 3 mm. long, widest (about 0.35 mm.) near the base and uniformly narrowed to the acute or narrowly obtuse, slightly denticulate apex, the margins below entire and flat or slightly recurved; costa one sixth or less the width of the leaf-base and nearly or quite percurrent; leaf-cells all more or less linear with slightly thickened walls, the median 6–8 μ wide and often 100 μ long, the basal wider, mostly 10–12 μ; perichaetial leaves with loosely clasping, somewhat larger base than those of the stem; seta rather weak, finally reddish, mostly 8–9 mm. long; capsule erect, oval-oblong, 1–1.5 mm. long without lid, becoming cylindric and somewhat contracted under the mouth when old and dry, the exothecal cells with somewhat thickened, nearly straight lateral walls, the median cells 16–20 μ wide by 35–60 μ long, the stomata at the base few or quite lacking; lid obliquely subulate, about 0.75 mm. long; annulus none; peristome-teeth about 250 μ high, regular, lanceolate, reddish brown below and vertically striate, divided about half way down into pale, papillose forks and borne on a basilar membrane scarcely extending above the rim; spores rough, 16 μ in diameter; calyptra cucullate, smooth, extending well down the capsule.

Polillo Island: May, 1909, *1260*.

In habit this species is much like *D. flaccidula* Mitt. of Fiji and Samoa, but the latter has an annulus, a different peristome, and spores only 3–4 μ in diameter.

Leucoloma molle (C. Müll.) Mitt. Luzon: Mariveles Mountain, July, 1909, *1273*.

DICRANOLOMA BLUMEI (Nees) Ren. Luzon: Mariveles Mountain, July, 1904, *1211*.

LEUCOBRYUM JAVENSE (Brid.) Mitt. Luzon: Mariveles Mountain, July, 1909, *1220*.

LEUCOBRYUM SANCTUM Hampe. Luzon: Tignaon, Lobayet Divide, May, 1909, *1250*.

LEUCOBRYUM SERICEUM Broth. Luzon: Tignaon Valley, Tayabas Province, 350 m. alt., May, 1909, *1249*.

OCTOBLEPHARUM ALBIDUM (L.) Hedw. Luzon: Mariveles Mountain, 760 m. alt., July, 1909, *1218*.

ARTHROCORMUS SCHIMPERI Dz. & Mb. Luzon: Mariveles Mountain, July, 1904, *1212*.

FISSIDENS INVOLUTUS Wils. Luzon: Legaspi or Lobayet, 1909, *1254a*. An Asiatic species not before credited to the Philippines.

FISSIDENS MITTENI Paris. Polillo Island: May, 1909, *1252*. This species of Ceylon, Java and Singapore is also new to the Islands.

FISSIDENS ZIPPELIANUS Dz. & Mb. Luzon: Lobayet River, Tayabas Province, on rock, 1909, *1253*.

SYRRHOPODON ALBOVAGINATUS Schwaegr. Luzon: Infanta, Tayabas Province, at sea-level, May, 1909, *1262*.

SYRRHOPODON MUELLERI Dz. & Mb. Luzon: Lobayet, Tayabas Province, 1909, *1237*.

SYRRHOPODON SUBTUBULOSUS Broth. Luzon: Mariveles Mountain, 400 m. alt., on trees, July, 1904, *1215*.

CALYMPERES DOZYANUM Mitt. Luzon: Tignaon Valley, Tayabas Province, May, 1909, *1234*.

CALYMPERES MOLUCCENSE Schwaegr. Luzon: Infanta, Tayabas Province, on mangrove shrubs, May, 1909, *1235*.

HYOPHILA COMMUTATA Broth. Polillo Island: May, 1909, *1259*. The first record of this species of Sumatra and Java for the Philippine Islands.

Didymodon orientalis (Willd.) comb. nov. (*Trichostomum orientale* Willd.; C. Müll. Syn. 1: 568. 1849.) Luzon: Legaspi, April, 1909, *1255*.

BARBULA ANGUSTIFOLIA (Hook. & Grev.) C. Müll. Luzon: Legaspi, on old walls, May, 1909, *1256*.

BARBULA CONSANGUINEA (Thw. & Mitt.) Sauerb. Luzon: Lobayet or Legaspi, 1909, *1254*.

Barbula lobayetensis sp. nov.

Dioicous, the male plant with one or two lateral appearing flowers each containing four or five antheridia, about 0.4 mm. long, and filiform paraphyses enclosed by two very broad, golden brown perigonial leaves scarcely longer than the antheridia: growing in rather thin mats with mostly simple stems 5–8 mm. long, radiculose below, leafy in the upper part and often bearing in the leaf-axils pale, branching filaments with star-shaped propagulae at their tips; stem-leaves irregularly flexuous or crispate when dry, up to 2.5 mm. long, nearly linear, sometimes slightly wider in the upper part, the somewhat recurved apex acute and denticulate, the margins below entire, papillose, flat in the upper leaf, sometimes recurved below; costa percurrent, 50–60 μ wide just above the base, in cross-section showing about four guide-cells, stereid bands above and below them and outer cells somewhat differentiated; cells of upper part of leaf distinct, papillose, mostly nearly square, about $6 \times 6\ \mu$, in the lower third, rectangular, paler, mostly 8–10 μ wide by 20–30 μ long; perichaetial much like the stem-leaves but with somewhat larger, scarcely clasping base; seta 8–10 mm. long; capsule cylindric, about 1.5 mm. long without lid, the exothecal cells with thin walls, the median about 16 μ wide by 40–50 μ long, those at the rim somewhat transversely elongate, in four or five rows, the stomata few, in one row near the base; lid subulate, about 1 mm. long; annulus none; peristome reddish brown, finely papillose, the basal membrane extending 40–50 μ above the rim and bearing filiform teeth about 0.5 mm. long and twisted once around; spores pale, smooth, about 10 μ in diameter; calyptra slightly rough at the apex.

Luzon: Lobayet, Tayabas Province, on earth, May, 1909, *1258*.

This species has propagula about like those of *B. sobolifera* Fleisch., but the leaves are very different; in habit it is quite similar to *B. pseudoehrenbergii* (Lorentz) Fleisch., a somewhat larger species with the apex of the leaf incurved and bearing in the axils of the leaves club-shaped propagula.

MACROMITRIUM ORTHOSTICHUM Nees. Luzon: Mariveles Mountain, 400 m. alt., on trees, July, 1904, *1215b*.

MACROMITRIUM ROBINSONII R. S. Williams, Bull. N. Y. Bot. Gard. 8: 344. 1914. Luzon: Mariveles Mountain, July, 1904, *1219*.

MACROMITRIUM SEMIPELLUCIDUM Dz. & Mb. Luzon: Mariveles Mountain, 400 m. alt., on trees, July, 1904, *1215a*.

POHLIA SAXENSIS R. S. Williams, Bull. N. Y. Bot. Gard. 8: 347. 1914. Polillo Island: May, 1909, *1272*.

ORTHOMNIUM STOLONACEUM Broth. Luzon: valley of Lobayet, Tayabas Province, May, 1909, *1241*.

WEBERA RUPESTRIS (Mitt.) C. Müll. Polillo Island: on wet banks, May, 1909, *1236a*. Not before credited to the Islands.

RACELOPUS PILIFER Dz. & Mb. Polillo Island: May, 1909, *1236*.

SPIRIDENS LONGIFOLIUS Lindb. Luzon: Mariveles Mountain, 760 m. alt., July, 1904, on trees, *1201*.

AEROBRYOPSIS LANOSA (Mitt.) Broth. Luzon: Mariveles Mountain, July, 1904, *1206*.

AEROBRYOPSIS LONGISSIMA (Dz. & Mb.) Broth. Luzon: Mariveles Mountain, 550 m. alt., July, 1904, *1207*.

FLORIBUNDARIA FLORIBUNDA (Dz. & Mb.) Fleisch. Luzon: Lobayet, Tayabas Province, 1909, *1245*.

NECKEROPSIS CRINITA (Griff.) Fleisch. Luzon: Infanta, Tayabas Province, 1909, *1240*; Lobayet, Tayabas Province, *1251*.

NECKEROPSIS LEPINIANA (Mont.) Fleisch. Luzon: Lobayet river, Tayabas Province, May, 1909, *1248*.

HOMALIODENDRON MICRODENDRON (Mont.) Fleisch. Luzon: Mariveles Mountain, on tree, July, 1904, *1217a*.

DISTICHOPHYLLUM OSTERWALDII Fleisch. Luzon: Lobayet, Tayabas Province, 1909, without number.

CALLICOSTELLA BECCARIANA (Hampe) Jaeg. Polillo Island: May, 1909, *1224*.

CALLICOSTELLA PAPILLATA (Mont.) Jaeg. Luzon: Tignaon, *1230*; Infanta, Tayabas Province, on trees, May, 1909, *1263a*.

CHAETOMITRIUM PAPILLIFOLIUM Bryol. Jav. Polillo Island: May, 1909, without number.

HYPOPTERYGIUM VRIESEI Bryol. Jav. Luzon: Tignaon, Tayabas Province, *1233*.

RHACOPILUM SPECTABILE Reinw. & Hornsch. Luzon: Tignaon, Tayabas Province, May, 1909, *1232*.

PSEUDOLESKEOPSIS DECURVATA (Mitt.) Broth. Luzon: valley of Lobayet, Tayabas Province, river bank, May, 1909, *1223*.

PELEKIUM VELATUM Mitt. Polillo Island: 1909, *1239*.

THUIDIUM PLUMULOSUM (Dz. & Mb.) Dz. & Mb. Luzon: valley of Lobayet, on trees at sea-level, May, 1909, *1237*.

ECTROPOTHECIUM CYPEROIDES (Hook.) Jaeg. Luzon: Lobayet, Tayabas Province, May, 1909, *1231*.

ECTROPOTHECIUM MORITZII C. Müll. Luzon: valley of Tignaon, Tayabas Province, on the ground at sea-level, May, 1909, *1221*.

TRISMEGISTIA LANCIFOLIA (C. Müll.) Broth. Luzon: valley of Tignaon, May, 1904, *1225*.

ISOPTERYGIUM MINUTIRAMEUM (C. Müll.) Jaeg. Apparently this species. Polillo Island: May, 1909, without number.

TRICHOSTELEUM HAMATUM (Dz. & Mb.) Jaeg. Luzon: Mariveles Mountain, on ground, logs, etc., 760 m. alt., July, 1904, *1218a*.

TRICHOSTELEUM PAPILLATUM (Harv.) Jaeg. Luzon: valley of Tignaon, on the ground at sea-level, May, 1909, *1222*. Polillo Island: May, 1909, *1228*.

TAXITHELIUM ALARE Broth. Luzon: Mariveles Mountain, on decaying twigs, etc., July, 1904, *1203*.

TAXITHELIUM INSTRATUM (Brid.) Broth. Luzon: Mariveles Mountain, 550 m. alt., July, 1904, *1205*.

VESICULARIA CAMPYLOTHECA (Broth.) Broth. Luzon: Infanta, Tayabas Province, May, 1909, *1226*. Polillo Island: May, 1909, *1229*.

VESICULARIA FILICUSPIS Broth. Luzon: valley of Tignaon, on the ground at sea-level, May, 1909, *1221a*.

VESICULARIA MEYENIANA (Hampe) Broth. Luzon: Infanta, Tayabas Province, on trees, May, 1909, *1263*.

SEMATOPHYLLUM HYALINUM (Reinw.) Jaeg. Luzon: Mariveles Mountain, 600 m. alt., *1208;* 760 m. alt., July, 1904, *1204;* 870 m. alt., *1202*.

HAWAIIAN SPECIES

DICRANELLA HAWAIICA (C. Müll.) Broth. Oahu: Honolulu, March, 1909, *1261*. Determined from the description only.

Hymenostomum ovale sp. nov.

Dioicous, the male plant with a single terminal flower, the inner antheridial leaves very short and broad, deeply concave, sometimes obtuse, enclosing six to eight antheridia and rather abundant, slightly longer paraphyses: growing in rather compact, pale greenish cushions with mostly simple stems 2–3 mm. high; stem-leaves crispate when dry, 1.5–2 mm. long, nearly linear, acutely pointed, the margins entire and more or less inrolled in the upper three fifths either wet or dry; costa about 45 μ wide just above the base and one sixth the width of the leaf-base, slightly excurrent into a more or less incurved point, smooth on the back, in cross-section near the middle showing four guide-cells, stereid bands above and below them and outer cells on the ventral side large, on the dorsal side, scarcely differentiated; leaf-cells mostly four-sided, about 8×8 μ in upper part, rather obscure and finely papillose on both upper and under surface, the basal cells rectangular, 8 μ wide by 25–30 μ long toward the costa, with slightly thickened, pale, not hyaline walls; perichaetial leaves much like those of the stem, but with slightly larger base; capsule oval, about 1 mm. long without the lid, the lid subulate, oblique, often nearly as long; exothecal cells thin-walled, elongate-hexagonal to rectangular, about 25 μ wide by 40–60 μ long, the stomata few, near the base, sometimes not evident; annulus and peristome none; spores rough, round, about 20 μ in diameter; calyptra cucullate, extending far below the lid, the apex smooth.

Oahu: Honolulu, March, 1909, *1247*.

Claopodium hawaiense sp. nov.

Dioicous: growing in thin, yellowish green mats with irregularly branching, smooth stems mostly less than 1 cm. long, bearing few radicles and spreading-flexuous, not decurrent, somewhat complanate leaves; leaves of stem and branches very similar, about 0.5 mm. long, ovate-lanceolate, the tapering point serrulate, the border of one row of more or less differentiated cells, serrulate all round; costa often pale, about 16 μ wide at the base, smooth, extending into the point, sometimes appearing slightly excurrent; cells of upper part of leaf mostly rhomboidal, about 6 μ wide by 16–20 μ long, below more elongate and irregular, the upper and median cells mostly unipapillate on each side, the papillae sometimes extending almost to the leaf-base and very prominent on the

branch-leaves but often almost lacking on the lower part of the stem-leaves; perichaetial leaves loosely convolute, erect, smooth, broadly oblong-lanceolate, the inner nearly 1.5 mm. long with rather short, narrowly acute, not quite entire point; seta rough throughout, 10–12 mm. long; capsule oblong, nodding, about 1 mm. long without the lid, constricted under the mouth when dry, the exothecal cells mostly oblong with walls much thickened at the angles, the stomata few, near the base; annulus large; outer peristome finely cross-striate below, papillose in the upper part, the inner about as high as the outer, consisting of a high basal membrane, rather pale and minutely papillose, bearing narrow, keeled segments with short, narrow slits along the median line and terminating in filiform points with one or two slender, nodose cilia nearly as long, between them; lid conical, acute, its height slightly exceeding the basal diameter; spores not quite smooth, about 10 μ in diameter.

Oahu: Honolulu, March, 1909, *1227*.

Compared with *C. prionophyllum* (C. Müll.) Broth. of India, Java and the Celebes, this species is perhaps slightly stouter and has broader, shorter pointed, more serrulate leaves as well as a rough seta.

The genus Teloschistes in North America

R. Heber Howe, Jr.

(WITH TWO TEXT FIGURES)

The genus *Teloschistes** which was proposed by Norman (Conat. gen. nullull. Lich., Nyt. Mag. Naturvid. 7: 228. *pl. 1, f. 4 a–g.* 1853) included under his division "(*a*) Thallus fruticulosus," beside the type species, *T. flavicans* (Sw.) Norm., only one other, *T. villosus* (Ach.) Norm., though under two other sections, i. e., *Phyllothallae* and *Placothallae*, he placed nine additional species, which have since found their proper positions in several other distinct genera. As both of the above named species are characterized by a radial thallus it is not surprising to find that later in 1861 (Gen. Het. Recog. 51) Th. Fries logically limited the genus to include only these two species and the radial *Lichen chrysophthalmus* L. The authors who have included bifacial (dorsiventral) species in Norman's genus have no good arguments in their favor, as recently pointed out by Monsieur Hue.

The present species have been found from time to time in many genera as follows: *Lichen* L., 1771; *Usnea* Hoffm., 1795; *Parmelia* Ach., 1803; *Physcia* Michx., 1803; *Borrera* Ach., 1810; *Cornicularia* Pers., 1826; *Evernia* Fries, 1831; *Hagenia* Rbhn., 1850; *Blastenio-spora* Trevis., 1853; *Tornabenia* Massal., 1853.

TELOSCHISTES Norm. em. Th. Fries

Description: *Thallus* caespitose or prostrate, branched, without rhizoids; *cortex* glabrous or rugose-lacunose; structure simple (hyphae parallel in the surface); *laciniae* terete, subterete or angularly compressed; cinereus or yellow; medulla and axis arachnoid, simple. *Gonidia* stratified (heteromerous): *Protococcoid*. *Soralia* normal. *Cephalodia* unobserved. *Apothecia* lecanorine, terminal or marginal; scutelliform, applanate or concave, rarely convex; marginate, disk concolorous. *Asci* clavate,

* By many authors spelled *Theloschistes*.

containing eight spores; paraphyses gelatinous, slender, apices branched and articulate. *Spores* simple or polari-bilocular,* hyaline, ellipsoid. *Spermagones* oblong-ellipsoid. *Sterigmata* simple. *Spermatia* cylindrical.

OBSERVATIONS: There are but three species of the genus common in North America, and only one of these has a wide distribution throughout the area.

Key to the species

Thallus glabrous.
- Laciniae slender, terete ..... *T. flavicans*
- Laciniae thickened, compressed ..... *T. chrysophthalmus*

Thallus hispid ..... *T. villosus*

TELOSCHISTES FLAVICANS (Sw.) Norm.

Lichen flavicans Sw. Nov. Gen. Spec. Pl. Prod. 147. 1788.
Teloschistes flavicans Norm. Nyt. Mag. Naturv. 7: 229. 1853.
Theloschistes chrysophthalmus b. *flavicans* Wallr. of Tuckerman.

TYPE: Untraced.

TYPE LOCALITY: "Jamaica."

ORIGINAL DESCRIPTION: "foliaceus, lineari-teretiusculus ramosus fulvus, scutellis planis marginalibus concoloribus."

FIGURES: Swartz, Lich. Amer. *pl. 2.* 1811.

DIAGNOSIS: *Thallus* prostrate, *slender*, *terete*, apothecial margins *eciliate.*

DESCRIPTION (typical): *Thallus* caespitose or prostrate, rarely subpendulous (alt. 5 cm.), subrigid, terete or subterete, yellow or pale virescent; *cortex* glabrous, rarely puberulent, often papillo-soraliate (white), sublacunose; *branches* thyrsoid-entangled (maximum width 2 mm.), apices attenuate, flexuous, fibrillose. *Apothecia* common (except at northern limit of range), lateral, concave, marginate, margins eciliate, disk concolorous to vitelline (maximum diameter 3 mm.). *Spores* polari-bilocular, 6.5–12 × 12–20 μ.

CONTINGENT PHASES: Unobserved.

SUBSTRATA: Trees and shrubs; "rocks and earth" *Herre.*

GEOGRAPHICAL DISTRIBUTION: Not uncommon in the Austral Zone. It extends on the Atlantic Coast from Newfoundland to Nantucket, Bermuda and Florida, and west to the Santa Cruz Peninsula, California. It occurs also throughout the West Indies and northern South America.

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* Rarely tetrablast.

OBSERVATIONS: This species, distinguished by its slender, subterete thallus, has a largely maritime distribution above the thirty-second parallel. It shows a transitional development of growth from the slender subpendulous plants growing in littoral localities to the more robust, caespitose plants that back the coast and intergrade toward the species *T. chrysophthalmus*. It shows also an interesting transitional coloration from the more virescent shades of the northern examples to the bright yellow southern Gulf specimens which approach or are identical with *Cornicularia crocea* Ach.

EXSICCATI: Merrill, Lich. Exsicc. *59*.

TELOSCHISTES CHRYSOPHTHALMUS (L.) Th. Fries

Lichen chrysophthalmus L. Mant. 311. 1771.

Theloschistes chrysophthalmus Th. Fries, Gen. Het. Recog. 51. 1861.

TYPE: In the Linnean herbarium, Burlington House, London, England.

TYPE LOCALITY: "Cap. b. spei."

ORIGINAL DESCRIPTION: "Foliaceus subimbricatus linearis lacerus ciliatus; peltis elevatis radiatis fulvis."

FIGURE: Wulf; Jacq. Coll. *pl. 4, f. 3*. 1786.

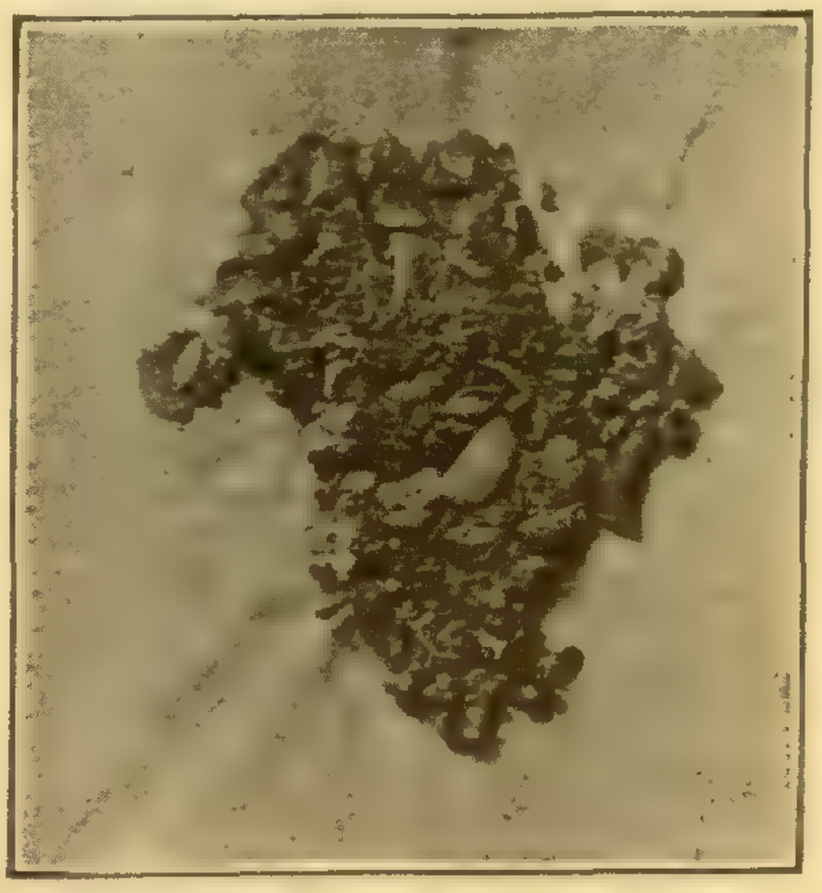

FIG. 1. The Linnean type of *Lichen chrysophthalmus*.

DIAGNOSIS: *Thallus* erect, *compressed*, apothecial margins *ciliate*.

DESCRIPTION (typical): *Thallus* caespitose (alt. 2 cm.), subrigid, subterete, compressed or angulate; yellow or pale virescent; *cortex* glabrous, often puberulent, lacunose-rugose, rarely reticulate; *branches* dichotomous (maximum width 3 mm.), generally paler below, apices multifid, fibrillose. *Apothecia* common, subterminal, concave or convex, marginate or emarginate, margins radiantly ciliate, disk yellow to vitelline (maximum diameter 5 mm.). *Spores* polari-bilocular 10–18 × 5–8 μ.

CONTINGENT PHASES: (*a*) *Thallus* cinereous, apothecial margins eciliate (= *Physcia exilis* Michx. Fl. Amer. 2: 327. 1803.).*

* Type locality: "Carolinae." Original Description: "P. pusilla, sordide exalbida-divaricatim intricatimque setaceo-ramosissima: scutellis minutis, lateralibus, planius,

SUBSTRATA: Trees, shrubs and rocks (type).

GEOGRAPHICAL DISTRIBUTION: Occurs commonly in the Austral and Transitional Zones from Ontario to North Carolina, west to Ohio, Illinois, Iowa, Wisconsin, Minnesota and California, and southward.

OBSERVATIONS: This species has the widest distribution of the members of the genus in our area, and is easly recognized. Though Dr. Wainio cites Michaux's *Physcia exilis* as a species on account of its pale thallus and eciliate apothecia, these characters are only phases of this plant. The color of the thallus is rarely pure yellow in true *T. chrysophthalmus*, and is not so in the type. Neither did Linnaeus describe it as yellow. The condition with ciliate apothecia is such a variable development that it hardly warrants even varietal recognition.

EXSICCATI: Cummings, No. Amer. Lichens *19, 84, 97, 98;* Howe, Lich. Novae Angliae *54;* Tuck. Lich. Amer. Sept. *80*, as *Parmelia chrysophthalma.*

TELOSCHISTES VILLOSUS (Ach.) Norm.

Parmelia villosa Ach. Meth. Lich. 254. 1803.

Teloschistes villosus Norm. Nyt. Mag. Naturv. 7: 228. 1853.

TYPE: In the Acharian herbarium, Helsingfors, Finland.

TYPE LOCALITY: "Peru," etc.

ORIGINAL DESCRIPTION: "Thallo membranaceo caespitoso villoso-hispido cinereo subtus albido nudo canaliculato, laciniis linearibus ramosis subflexuosis; scutellis lateralibus rubris."

FIGURE: Ach. Lich. Univ. *pl. 9, f. 8.* 1910.

DIAGNOSIS: *Thallus* suberect, compressed-*canaliculate, hispid,* apothecial disk *red.*

DESCRIPTION (typical): *Thallus* caespitose (alt. 4 cm.), subrigid, compressed-canaliculate, cinereus; *cortex* glabrous, hispid above; dichotomous (maximum width 2 mm.), laciniate, attenuate, apices subterete. *Apothecia* uncommon, subterminal, concave, marginate, disk red (maximum diameter 3 mm.). *Spores* simple, 11–16 × 4.5–6 μ.

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culis, nitide croceis, margine simplici." = *Parmelia chrysophthalmus β exilis* Tuck., Synop. Lich. N. E. 31. 1848. Also *Physcia villosa* var. *Dickienna* Linds. Trans. Roy. Soc. Edin. **22**: 254. 1867. *Teloschistes flavicans* f. *cinerascens* Müll. Arg. (Bot. Jahrb. **15**: 513. 1893) shows the parallel phase in the preceding species.

SUBSTRATA: Shrubs.

GEOGRAPHICAL DISTRIBUTION: Not uncommon in the Transition Zone from Santa Cruz Island south to Lower California.

OBSERVATIONS: This well marked species was added to our lichen flora in 1910 when I recorded specimens collected by Miss Blanche Trask in 1892.* It had been secured, however, in Lower California at an earlier date and distributed in Miss Cummings's Exsiccati.

EXSICCATI: Cummings, No. Amer. Lichens *154*.

FIG. 2. The Acharian type of *Parmelia villosa*.

* See also Hasse, Bryologist **13**: 61. 1910.
Bot. Gaz. **49**: 320; **50**: 159. 1910.

New species of Uredineae—IX*

JOSEPH CHARLES ARTHUR

In the interim of four years since the last group of species was published in this series a considerable number of forms have been separated which appear to be undescribed. Some of these forms have been recognized for a long time, such as *Puccinia Dondiae*, collected in 1882, *P. agnita* and *P. valida*, both collected in 1898, but as they have been known from single collections only, their previous publication has been withheld, hoping that more information would become available. The species are now issued to call the attention of collectors to them.

Four species of short-cycle forms are included in this group, *Uromyces abbreviatus* on *Psoralea*, *Puccinia tumamocensis* on *Dipterostemon*, *P. agnita* on *Claytonia* and *P. Fraseri* on *Hieracium*. These are especially interesting, as they are on common hosts bearing long-cycle species. The first two mentioned are closely correlated with more abundant long-cycle forms occupying the same region and the same hosts. Such forms are often overlooked in the too common way of naming collections without much regard to the life cycle. To the student interested in the phylogeny and classification of the rusts these short-cycle forms present a suggestive series of problems, and their recognition under distinctive names is highly important.

Uropyxis Wootoniana sp. nov.

O. Pycnia not seen.

II. Uredinia hypophyllous, numerous, scattered, rarely confluent, round to oblong, 0.5–1 mm. long, early naked, somewhat pulverulent, pulvinate, light cinnamon-brown; paraphyses absent; urediniospores terete-fusiform or ovate-fusiform, 13–19 by 35–45 μ; wall pale yellow or colorless, 2–4 μ thick, thicker at apex, 5–9 μ with hyaline umbo, finely and closely verrucose, the pores 8–12

* New Species of Uredineae I–VIII: Bull. Torrey Club **28**: 661–666. 1901; **29**: 227–231. 1902; **32**: 1–8. 1904; **33**: 27–34, 513–522. 1906; **34**: 583–592. 1907; **37**: 569–580. 1910; **38**: 369–378. 1911.

in two zones of 4–6 pores each, one above and one below the equator.

III. Telia hypophyllous, similar to the uredinia, chocolate-brown; teliospores broadly ellipsoid, 19–23 by 23–27 μ, rounded above and below, moderately constricted at septum; wall chestnut-brown, 3–5 μ thick, with longitudinal ridge-like, parallel striations, the pores lateral, indistinct; pedicel colorless, terete, 3–5 μ thick, 145–165 μ long, the wall thickened to obliterate the lumen except at the base.

On *Berberis haematocarpa* Wooton (*Odostemon haematocarpus* Heller), Organ Mountains, New Mexico, December 23, 1903, *3732;* Filmore Canyon, Organ Mountains, New Mexico, November 9, 1908 (type); Queen, Guadalupe Mountains, New Mexico, August 1, 1909, all by E. O. Wooton. I am pleased to have the opportunity to name this conspicuous and distinctive rust in honor of the able botanist who has been highly successful in making known the plants of New Mexico, and who not only supplied all the specimens of the rust so far seen, but also detected and described the host. The host is an evergreen shrub occurring on the mountain slopes in the southern part of New Mexico and Arizona.

Uromyces ornatipes sp. nov.

O. Pycnia not seen.

I. Aecia scattered about the slightly swollen but not discolored stem for 0.5–1 cm. in length, cylindric, 0.5–0.8 mm. high, with margin erect, erose or lacerate; peridial cells rhomboidal, 18–21 by 26–32 μ, overlapping, the outer wall smooth, 3–4 μ thick, the inner wall verrucose, 5–7 μ thick; aeciospores angularly globoid or ellipsoid, 18–23 by 24–27 μ; wall colorless, 1.5–2 μ thick, sometimes appearing thicker, very inconspicuously verrucose.

III. Telia among the aecia, seemingly arising from the aecial sori, round, 0.3–0.5 mm. in diameter, rising somewhat above surface of host, blackish brown; teliospores ellipsoid, 21–26 by 27–32 μ, rounded above and below; wall dark chocolate-brown, often opaque, 2–2.5 μ thick, thicker above, 5–7 μ, indistinctly striate; pedicel colorless, joined to the spore by a tinted collar, solid, 7–9 μ in diameter above, increasing to 10–13 μ in lower part, upper part smooth, lower part strongly rugose transversely.

Urediniospores not uncommon in the telial sori, ellipsoid, 21–24 by 26–33 μ; wall golden brown, 1.5–2.5 μ thick, sparsely verrucose, the pores equatorial, indistinct but probably 4.

On *Phrygilanthus Sonorae* (S. Wats.) Rose & Daniels (*Loranthus Sonorae* S. Wats.), Cape San Lucus, Lower California, Mexico, March, 1911, *J. N. Rose 16396*. In reference to the host Dr. Rose writes that no species of the true *Loranthus* has yet been found in America. The rust is a striking one. As no pycnia could be found, and the teliospores appear to arise from the same mycelium as the aecia, it seems probable that the aecia in this collection are the secondary form, and that the rust does not produce separate uredinia, but simply occasional urediniospores in the telial sori. The collection, although not ample, shows a fine development of the rust.

Uromyces abbreviatus sp. nov.

O. Pycnia hypophyllous, scattered among the telia, not numerous or conspicuous, subepidermal, in section globose, 130–150 μ in diameter.

III. Telia hypophyllous, scattered over large areas, round, 0.2–0.5 mm. across, early naked, pulverulent, chocolate-brown; teliospores ellipsoid or broadly obovoid, 20–23 by 24–37 μ, rounded at both ends, or somewhat narrowed below; wall chestnut-brown, uniformly thin, 3 μ, with a slight umbo over the pore, smooth; pedicel colorless, delicate, half as long as the spore, fugacious and appearing short.

On *Psoralea Purshii* Vail, Winnemucca, Nevada, July 1901, *Griffiths & Morris*, type (Griff. West Am. Fungi *390*); on *P. physodes* Dougl., Puget Sound Navy Yard, Bremeston, Washington, July 22, 1912, *E. Bartholomew 4752*. There is also an undated collection of this species in the Farlow Herbarium at Cambridge, Massachusetts, collected at Calistoga, California, by H. W. Harkness, on *P. physodes*. This species is the short-cycle form corresponding to *Uromyces Psoraleae* Peck. The aspect of the fungus in gross and microscopic characters is scarcely different from the corresponding spore-structures of the long-cycle form. In the specimens seen the telia are more numerous and highly pulverulent, making the fungus more conspicuous.

Puccinia Carnegiana sp. nov.

O. Pycnia amphigenous, in oval groups 1–2 mm. long, usually surrounded by aecia, or among them, subepidermal, globoid in section, about 200 μ in diameter; ostiolar filaments about 35 μ long.

I. Aecia amphigenous, in oval groups 1–4 mm. long on brownish spots, when mature falling away leaving the ruptured epidermis conspicuous; peridium delicate, deeply lacerate, recurved, the peridial cells lanceolate, rarely somewhat rhomboidal, pointed, 40–60 μ long, the outer wall 3–5 μ thick, smooth and transversely striate, the inner wall somewhat thinner, verrucose; aeciospores globoid, 23–27 by 24–34 μ; wall colorless, 2–3 μ thick, finely verrucose.

III. Telia amphigenous, scattered, often immediately outside or within the aecial cups, rather tardily naked by a longitudinal slit, blackish, slightly pulverulent; teliospores ellipsoid or oblong, 27–34 by 42–58 μ, slightly or not constricted at septum, usually rounded at both ends; wall blackish when mature, uniformly 2.5–3.5 μ thick, occasionally slightly thicker above, coarsely and prominently tuberculate; pedicel colorless, fragile, once length of spore or less.

Urediniospores in the telia rather common, broadly ellipsoid or obovoid, 27–35 by 32–42 μ; wall golden- or cinnamon-brown, about 1.5 μ thick, finely and moderately verrucose-echinulate, the pores 12–15, scattered.

On *Dipterostemon pauciflorus* (Torr.) Rydb. (*Brodiaea capitata pauciflora* Torr., *Dichelostemma pauciflorum* Standley), Tumamoc Hill, on grounds of the Desert Botanical Laboratory of the Carnegie Institution of Washington, Tucson, Arizona, altitude 2,700 feet, February 25, III, *5800*, February 26, O, I, III, *5801* type, February 26, O, I, *5802*, all by J. C. Arthur and F. D. Fromme; also March 12, III, by W. A. Cannon. The collections were made at different spots on Tumamoc Hill in vicinity of the Laboratory, and in the year 1914.

A part of *5802* was used for a culture made at the protected south side of the Laboratory building in the open, the resulting infection being watched and the matured sori transmitted by Dr. W. A. Cannon of the Laboratory staff. This culture is reported in Mycologia (7: 85. March, 1915), under the name *Puccinia nodosa*. A water culture was made of the urediniospores, which showed that they were capable of germination. Some aberration was observed in their behavior, but the stay at the Laboratory was too brief to obtain exact data, or to decide upon their significance. The urediniospores in a number of collections, kindly sent to Lafayette, Indiana, by Dr. Cannon, could not be made to germinate. The behavior of urediniospores has never

been studied in a species of this character, in which the sowing of aeciospores produces telia directly without the intervention of uredinia. It is probable that this is the first time that such spores have been seen to germinate. It is not known whether or not they are capable of infecting a plant and reproducing the rust.

Puccinia nodosa Ellis & Harkn., a species found on *Dipterostemon capitatus* (Benth.) Rydb. (*Brodiaea capitata* Benth.) from San Francisco to the southern part of California, differs from the one here proposed by having a definite uredinial stage with prominent sori. The hosts of the two species are similar, differing most strongly in the abundance of flowers in the umbels. *D. capitatus* is a Californian species, while *D. pauciflorus* ranges through southern Arizona into the border of New Mexico. *Puccinia nodosa* has not yet been cultured.

It was through the kindness and generous assistance of the director of the Desert Laboratory and of his staff of workers that the discovery of this rust and the brief but highly significant studies of it were made possible, and it is to acknowledge in part this aid to science that the first word in the title of the institution has been chosen for the specific name of the new species.

Puccinia tumamocensis sp. nov.

O. Pycnia hypophyllous in small groups surrounded by the telia, subepidermal, globoid as seen in section, 130–190 μ in diameter; ostiolar filaments 30–40 μ long.

III. Telia hypophyllous, closely placed in elliptical groups 3–10 mm. long surrounding the pycnia, elliptical, 1–2 mm. long, becoming naked by longitudinal rupture of the epidermis, pulverulent, blackish; teliospores broadly ellipsoid, 32–42 by 48–61 μ, slightly or not constricted at septum, rounded at both ends; wall dark chestnut- to blackish-brown, uniformly 3–5 μ thick, coarsely and prominently tuberculate; pedicel colorless, fragile, appearing short.

On *Dipterostemon pauciflorus* (Torr.) Rydb. (*Brodiaea capitata pauciflora* Torr.), Tumamoc Hill, grounds of the Desert Botanical Laboratory, Tucson, Arizona, altitude 2,700 feet, February 26, 1914, *J. C. Arthur & F. D. Fromme 5801a.* This is the short-cycle form corresponding to the long-cycle species, *P. Carnegiana*

and *P. nodosa*. The teliospores are somewhat broader than in those species, and the general appearance is that of a more luxuriant growth. There is considerable resemblance to the short-cycle species *P. Lojkojana* Thüm., occurring in southeastern Europe on *Ornithogalum* and *Muscari*. The name has been chosen to indicate the only locality where the species has yet been found, and in compliment to the management of the Desert Botanical Laboratory, who so enthusiastically assisted Dr. Fromme and myself in our studies of the rust parasites of the vicinity. Tumamoc Hill is a rocky eminence having the sparse desert vegetation characteristic of the arid region about. In the early spring *Dipterostemon*, more usually called *Brodiaea*, is abundant over the whole area, up to the very doors of the Laboratory, its attractive flowers lending a special charm to the place. This species of rust and *P. Carnegiana* occur here and there in fair abundance, but are not general. The isolated manner of occurrence gave some countenance to the suggestion that mycelium hibernated in the bulbs. The problem of continuity through the long arid season is, however, one that will require considerable investigation. The interest in its solution is not confined to this species, or even to similar desert species, important as such knowledge would prove, but extends to species in other regions, including some of highly economic value.

Puccinia agnita sp. nov.

O. Pycnia chiefly epiphyllous, loosely grouped on discolored spots, punctiform, moderately conspicuous, subepidermal, angularly globoid in section, 65–115 μ in diameter; ostiolar filaments about 35 μ long.

III. Telia chiefly hypophyllous, irregularly grouped on pale spots 4–6 mm. across, round or oblong, 2–8 mm. across, at first covered by the membranous epidermis, soon naked, very pulverulent, light chestnut-brown; teliospores ellipsoid, 21–27 by 29–42 μ, rounded or obtuse at both ends, slightly or not constricted at septum; wall golden-brown, uniformly thin, 1.5–2 μ, inconspicuously verrucose, the pore in upper cell apical, in lower cell depressed two-thirds below septum, both pores with hyaline papilla; pedicel colorless, fragile, appearing short.

On *Claytonia megarrhiza* (A. Gray) Parry, Cumberland Mine, La Plata Mountains, Colorado, altitude 12,000 feet, July 15, 1898,

Baker, Earle & Tracy 1045. A short-cycle form corresponding to *Puccinia Claytoniata* (Schw.) Peck, but with the teliospores slightly broader, and the telia more definitely grouped.

Puccinia Fraseri sp. nov.

O. Pycnia not seen, probably wanting.

III. Telia hypophyllous, sometimes also on upper surface of leaf, evenly scattered over large areas, usually covering the whole leaf, round, 0.2–0.5 mm. across, strongly pulvinate, pale cinnamon-brown, usually whitish by germination, ruptured epidermis not visible; teliospores oblong, 15–21 by 37–45 μ, rounded or obtuse at both ends, slightly or not constricted at septum; wall very pale cinnamon-brown or nearly colorless, 1.5–2.5 μ thick, much thicker above, 5–9 μ, smooth; pedicel colorless, broad, 6–10 μ, once length of spore or less, the wall very thin but firm.

Urediniospores occur occasionally among the teliospores, obovoid, 16–21 by 23–29 μ; wall pale yellow or nearly colorless, 2–3 μ thick, sparsely echinulate, the pores indistinct, probably 3 or 4, equatorial.

On *Hieracium scabrum* Michx., Pictou, Nova Scotia, June 19, 1909, May 25 and June 22, 1910, *W. P. Fraser*, the last collection being taken as the type. It would be natural to infer that this short-cycle, leptoform species would be correlated with the common long-cycle form on the same and similar hosts. The common *Puccinia Hieracii* occurs in the same locality on *H. scabrum*, but its ellipsoid, verrucose teliospores indicate a different relationship. I take pleasure in dedicating the species to Mr. Fraser, who has furnished all the material for its study, and who is also entitled to much credit for his fine contributions to the knowledge of Uredinales and especially of the life history of a number of species.

Puccinia valida sp. nov.

II. Uredinia hypophyllous, scattered unevenly, irregularly rounded or somewhat elongated, 0.3–0.7 mm. across, early naked, pulverulent, cinnamon-brown, ruptured epidermis evident; urediniospores ellipsoid to broadly obovoid, 17–21 by 22–28 μ; wall cinnamon-brown, 1.5–2 μ thick, moderately echinulate, the pores 2, somewhat superequatorial.

III. Telia hypophyllous, scattered, moderately pulvinate, similar in appearance to the uredinia, but slightly darker; telio-

spores oblong or ovate-oblong, 13–19 by 28–39 μ, rounded at apex, somewhat narrowed below, slightly constricted at septum; wall cinnamon-brown, thin, 1 μ, thickened above, 4–7 μ, smooth; pedicel tinted, fragile, as long as the spore, or broken off much shorter.

On *Dioscorea convolvulacea* Schlecht & Cham., Jalapa, Mexico, October 2, 1898, *E. W. D. Holway 3115*. The host has recently been examined at the Gray Herbarium, where a phanerogamic specimen is deposited. The species differs from the nearly allied *D. grandifolia* Schlecht. in having much shorter leaves and longer staminate racemes. A number of species of rusts have been described on *Dioscorea*, and placed under different genera, from each of which the above form appears to be wholly distinct.

Puccinia Dondiae sp. nov.

II. Uredinia amphigenous; urediniospores broadly ellipsoid, 26–29 by 32–39 μ; wall cinnamon-brown, 1.5 μ thick, finely and closely echinulate, the pores 8, scattered.

III. Telia amphigenous, large, 0.4–0.7 mm. across, pulverulent, blackish-brown; teliospores ellipsoid, 32–39 by 42–51 μ, rounded at both ends, not constricted at septum; wall dark chocolate-brown, uniformly 4–5 μ thick, prominently and coarsely verrucose; pedicel nearly or quite as long as the spore, colorless or slightly tinted, more or less hygroscopic.

On *Dondia intermedia* (S. Wats.) Heller, San Diego, California, April 19, 1882, *Marcus E. Jones 3153*. The host of this collection has recently (January, 1915) been determined by Mr. Paul C. Standley of the United States National Herbarium. Although collected thirty-three years ago the species does not appear to have been found since.

Aecidium Farameae sp. nov.

O. Pycnia epiphyllous, in small groups 1–3 mm. across, or scattered over larger hypertrophied areas, becoming blackish-brown, subepidermal, deep-seated, 144–200 μ in diameter; ostiolar filaments short.

I. Aecia hypophyllous and caulicolous, in circular groups 2–5 mm. across, on discolored, slightly thickened spots, or scattered widely on much hyptertrophied and distorted petioles and shoots, low cylindric, small, 0.2–0.3 mm. in diameter; peridium erect, irregularly torn; aeciospores angularly globoid or oblong, 23–26 by 26–34 μ; wall colorless, 1.5 μ thick, much thicker above, 7–12 μ, moderately and evenly verrucose.

On *Faramea occidentalis* (L.) A. Rich., San Diego de los Baños, province of Pinar del Rio, Cuba, August 31 to September 3, 1910, *Britton, Earle & Gager 6855*. The deep-seated pycnia and aecia are especially characteristic of this species of rubiaceous rust. It may or may not be heteroecious.

Uredo fatiscens sp. nov.

II. Uredinia amphigenous, scattered or somewhat striate on yellowish or brownish spots, oblong, 0.3–0.5 mm. long, pulvinate, rather tardily naked, cinnamon-brown; urediniospores fusiform, 16–19 by 42–58 μ, narrowed at both ends, provided with a hyaline beak at apex, 5–7 μ long; wall golden-brown, thin, 1–1.5 μ, thickened above with a beak, the pores at or slightly above the equator, 2.

On *Carex Pseudo-Cyperus* L., Leland, Michigan, August 29, 1913, *J. C. Arthur*. This highly distinctive rust, whose slender, fusiform spores are very unlike those of any other cyperaceous rust known to the writer, was found in an open marsh close to the east shore of Lake Leelanau. Only a small infected area on two or three leaves was secured. The host was in fruit, and its determination has been made by Dr. Theo. Holm.

PURDUE UNIVERSITY,
LAFAYETTE, INDIANA

INDEX TO AMERICAN BOTANICAL LITERATURE

1915

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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Appel, O. The control of cereal and grass smut and the *Helminthosporium* disease in Holland and Germany. Phytopathology **5**: 230–232. Au 1915.

Arthur, J. C. Uredinales of Porto Rico based on collections by F. L. Stevens. Mycologia **7**: 168–196. 28 Jl 1915.

Includes descriptions of *Ravenelia Stevensii*, *Argomyces insulanus*, and *Uromyces densus*, spp. nov.

Bailey, I. W., & Shepard, H. B. Sanio's laws for the variation in size of coniferous tracheids. Bot. Gaz. **60**: 66–71. *f. 1.* 16 Jl 1915.

Bailey, L. H. Some present needs in systematic botany. Proc. Am. Philos. Soc. **53**: 58–65. 19 Je 1915.

Bakke, A. L. The water relations of the mesquite. Ames Forester 3: 87–91. 1915. [Illust.]

Ball, C. R. Notes on North American willows—II. Bot. Gaz. **60**: 45–54. *f. 1–3.* 16 Jl 1915.

Includes *Salix pennata* sp. nov.

Blake, S. F. A revision of *Salmea* and some allied genera. Jour. Bot. **53**: 193–202. Jl 1915; 225–235. Au 1915.

Five new species are described.

Blake, S. F. Some neglected names in Walter's Flora Caroliniana. Rhodora **17**: 129–137. 10 Jl 1915.

Blake, S. F. *Steiractinia*, a new genus of Compositae. Jour. Bot. **53**: 153–158. *pl. 539.* Je 1915.
Six new species are described.

Blake, S. F. Three new Perymeniums. Jour. Bot. **53**: 135–137. My 1915.

Blake, S. F. *Trichospira verticillata* (L.) Blake n. comb. Torreya **15**: 106. 29 Je 1915.

Blodgett, F. M. Sweet pea powdery mildew. Phytopathology **5**: 237. Au 1915.

Bonazzi, A. Cytological studies of *Azotobacter chroococcum*. Jour. Agr. Research **4**: 225–240. *pl. 31–33.* 15 Je 1915.

Bose, J. C. Plant-autographs and their revelations. Smithsonian Inst. Ann. Rep. **1914**: 421–443. *f. 1–18.* 1915.

Brannon, M. A. The action of Salton Sea water on vegetable tissues. Carnegie Inst. Wash. Publ. 193: 71–78. *pl. 12–14.* 1915.

Britton, N. L. Further botanical exploration of Porto Rico. Jour. N. Y. Bot. Gard. **16**: 103–112. 5 Jl 1915.

Britton, N. L. Studies of West Indian plants—VI. Bull. Torrey Club **42**: 365–392. 29 Jl 1915.
Includes descriptions of 43 new species in *Coccolobis* (5), *Tabebuia* (14), *Anastraphia* (12), *Cyperus* (1), *Psilocarya* (1), *Rynchospora* (1), *Cassia* (1), *Purdiaea* (3), *Rheedia* (1), *Mayepea* (1), *Agalinis* (1), *Piriqueta* (1) and *Jacaranda* (1).

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BULLETIN

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TORREY BOTANICAL CLUB

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Notes on Carex—IX

KENNETH KENT MACKENZIE

CAREX STRAMINEA WILLD. AND SOME OF ITS NEAREST ALLIES

The original description of *Carex straminea* Willd. (Schkuhr, Riedgr. 49. 1801) reads as follows: "C. spiculis ovatis distantibus, capsulis obovatis acuminatis, margine hispidis." The accompanying figure (*f. 34*) illustrates a plant with a strongly obovate perigynium body abruptly contracted into a beak much less than half the length of the body. The identity of the species was for many years obscured owing to the fact that Schkuhr later (Riedgr. Nachtr. *f. 174.* 1806) gave another illustration of a plant which he took for *Carex straminea* Willd. Unfortunately he illustrated a related but distinct species (*Carex straminea* var. *brevior* Dewey), and further changed the description (*l. c.* 23) to correspond with the plant so illustrated.

Professor Bailey (Mem. Torrey Club 1: 21–22. 1889) pointed out this error, and at the same time identified *Carex straminea* Willd. with a slender weak plant which had been distributed as *Carex tenera* Dewey by Sartwell and by Olney. In this identification he was followed by Professor Fernald (Proc. Am. Acad. 37: 450. 1902), who later also pointed out that the plant distributed by Sartwell and by Olney was in fact the real *Carex tenera* Dewey (Rhodora 8: 165. 1906). The fact that this plant has an ovate perigynium body, and the genuine *Carex straminea* Willd. an obovate perigynium body was not pointed out. Field work and a steady accumulation of specimens has served to emphasize the differences between these

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two plants, and to justify Dewey in having proposed *Carex tenera* as a distinct species.

The real *Carex straminea* is a tall slender but rather stiff plant of wet soil with stiff, little flexuous inflorescence; the lower nodes are exposed, and the sheaths are green-striate ventrally nearly to the apex, the hyaline portion being short. The body of the perigynium is strongly obovate and abruptly contracted into a short beak less than half the length of the body; it is thin except where distended by the achenes, and is strongly but finely five- to seven-nerved ventrally over the stipitate achene. The scales are not brownish tinged, but are hyaline with a conspicuous green strip on each side of the midvein.

On the other hand, *Carex tenera* Dewey is usually a very slender plant of dry soil with slender, flexuous inflorescence; the lower nodes are not exposed and the sheaths are conspicuously hyaline ventrally. The thick ovate perigynium tapers into the short beak, and is less strongly three- to five-nerved ventrally over the substipitate achene. The scales are reddish brown tinged and lack the conspicuous green strip on each side of the midvein.

After separating these two plants a third element still remained in the aggregate which had been referred to *Carex straminea*. This has the nodes and sheaths as in *Carex tenera*. The leaves, however, are wider, and the plant is much less slender. The inflorescence consists of from four to nine spikes, which are normally strongly clavate at the base and not rounded as in the other two species. The body of the perigynium is suborbicular or orbicular and contracted into a beak half the length of the body, which is thick and but faintly three- to five-nerved ventrally. The scales are more or less strongly reddish-brown tinged. This plant is an exact match for *Carex festucacea* Schkuhr (Riedgr. Nachtr. 23. *f.* 173. 1806), and should take that name.

The plant which has of late years been treated as *Carex festucacea* and as *Carex festucacea* var. *brevior* (Dewey) Fernald commonly has three to six little separated spikes rounded at the base, but occasionally has more numerous and more separated spikes which are then apt to be more staminate and hence more clavate at the base. It is well distinguished from the species above described by the perigynium exceeding 4 mm. in length, while the

beak is much less than half as long as the body. The suborbicular achenes are twice as large as the broadly oval achenes of genuine *Carex festucacea*. This plant should be known as **Carex brevior** (Dewey) Mackenzie,* **comb. nov.**

Detailed descriptions of each of these three species and lists of the specimens examined follow.

CAREX STRAMINEA Willd.; Schk. Riedgr. 49. *pl. G, f. 34.* 1801

Densely cespitose, the culms slender, 2.5–9 dm. high, exceeding leaves, sharply triangular and roughened on the angles immediately beneath the head, the lower leaves much reduced. Leaves with well-developed blades three to five to a fertile culm, on the lower third but much separated, the blades flat, erect-ascending, attenuate, 2–3 mm. wide, usually 5–15 cm. long, the margins rough; the sheaths loose, green-striate ventrally nearly to apex; sterile culm leaves more numerous. Spikes three to ten, aggregated, approximate or more or less separate in a stiff head 2.5–6 cm. long, the spikes 6–10 mm. long, 4.5–6 mm. wide, ovoid, rounded at apex, the terminal long clavate and staminate at base, the lateral rounded or short clavate and sparingly staminate at base with fifteen to thirty appressed-ascending perigynia with erect or ascending or somewhat spreading beaks; bracts scale-like or the lowest often cuspidate-prolonged, 5–20 mm. long. Scales ovate, acute or short acuminate, white-hyaline with green strip on each side of mid-vein slightly light brownish tinged, narrower and shorter than perigynia. Perigynia green or greenish, the body obovate, thin except where distended by achene, wing-margined to base, 1.5–2 mm. broad, 3.5 mm. long, many-nerved on outer face, lightly about five-nerved on inner face over achene, with an additional nerve in either margin, rounded at base, abruptly contracted into a beak half the length of body, the beak obliquely cut dorsally, flat and strongly serrulate, as is upper third of perigynium body. Achenes lenticular, brownish, oval-oblong, substipitate, 1.5 mm. long, 0.75 mm. wide, slightly apiculate, and continuous with slender flexuous style; stigmas two.

The more strongly developed specimens of this species bear a strong resemblance to *Carex alata* Torr. They are to be distinguished by the smaller perigynia which are more strongly nerved ventrally and only obliquely cut at the apex, as also by the less strongly stipitate achenes.

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* *Carex straminea* var. *brevior* Dewey, Am. Journ. Sci. **11**: 158. 1826.

SPECIMENS EXAMINED

NEW YORK: Yonkers, *Bicknell*, June 16, 1895 (C.); Lowerre, *Bicknell*, July 4, 1891, June 9, 1895 (C.); "New York," *Torrey* (C.).

NEW JERSEY: Mickleton, *Crawford*, May 10, 1892 (P.); Trenton, *Brown*, May 29, 1904 (P.); Riddleton, Salem County, *MacElwee*, June 15, 1895 (P.); Eagle Rock, Essex County, *Mackenzie 1445*, July 4, 1905 (K. M.).

PENNSYLVANIA: Tannersville, *Brown*, July 4, 1896 (P.); Ex Herb. *Schweinitz* (P.); West Philadelphia, *MacElwee*, June 14, 1894 (P.); Point Pleasant, *Fretz*, June 22, 1898 (P.); Jordan Valley, Lehigh County, *Pretz 6800, 6809*, July 4, 1914 (P.); Diamond Rock, Chester County, *Bartram 1532*, June 18, 1911 (P.); Pricetown, Bucks County, *Britton*, July, 1915 (N. Y.).

DELAWARE: Vandyke, Newcastle County, *Long*, July 3, 1909 (P.); Newcastle County, *Commons*, June, 1872 (P.).

MARYLAND: Hyattsville, *Steele*, June 7, 1903 (K. M.).

DISTRICT OF COLUMBIA: Washington, *Steele*, June 5, 1902 (K. M.); Washington, *Kearney*, June 6, 1897 (N. Y.).

INDIANA: Patoka, Gibson County, *Deam 13318*, June 9, 1913 (K. M.).

ILLINOIS: Cobden, *Earle 730*, May 23, 1912 (N. Y.).

MISSOURI: Atherton, *Bush 6800*, June 7, 1912 (N. Y.); Greenwood, *Bush 6707A*, May 20, 1912 (N. Y.).

TENNESSEE: Henderson, *Bain 501*, May 13, 1893 (C.).

GEORGIA: Milledgeville, *Boykin* (C.); Burke County, *Harper 797*, June 5, 1901 (N. Y.).

FLORIDA: *Chapman* (C.); Jacksonville, *Curtiss 4743*, May 3, 1894 (C.).

LOUISIANA: *Hale*, 1845 (C.); *Leavenworth*, 1845 (C.).

CAREX TENERA Dewey, Am. Journ. Sci. **8**: 97. 1824
(also **9**:. *pl. c, f. 9.* 1825)

Carex festucacea var. *tenera* Carey; A. Gray, Man. 545. 1848.
Carex straminea var. *tenera* Boott, Ill. Car. **3**: 120, *pl. 384.* 1862.
Carex tenera forma *erecta* Olney; Kükenthal, Engler's Pflanzenreich **4**[20]: **205.** 1909 (as synonym).

Densely cespitose, the culms slender, erect, 3–7.5 dm. high, sharply triangular and roughened on angles above, much ex-

ceeding leaves, dark at base, the lower leaves reduced, the lower nodes not exposed. Leaves with well-developed blades three to five to a fertile culm, on lower third but not bunched, the blades flat, 1.5–2.5 mm. wide, usually 7.5–30 cm. long, the sheaths tight, but obscurely septate-nodulose, conspicuously hyaline ventrally and prolonged upward. Inflorescence of four to eight spikes in a more or less strongly moniliform head 2.5–5 cm. long, the spikes ovoid, gynaecandrous, rounded at apex, 6–10 mm. long, 4.5–6 mm. wide, with ten to twenty appressed perigynia above, the tips appressed, rounded and with few staminate flowers at base (except in terminal spike); lowest bract short, setaceous, the upper scale-like. Scales ovate, acute, hyaline with green midvein, and tawny tinged, narrower and shorter than perigynia. Perigynia green or in age straw-colored, ovate, 3.5 mm. long, nearly 2 mm. wide, the body suborbicular, thickish, plano-convex, winged to base, strongly about five-nerved dorsally over achene with an additional nerve in both margins and similarly but less strongly nerved ventrally, rounded and sessile at base, contracted into beak half length of body, the beak tawny tipped, obliquely cut dorsally, flat and strongly serrulate, as is upper half of perigynium body. Achenes broadly ovoid, plano-convex, light brown, substipitate, 1.25 mm. long, 1 mm. wide, apiculate, the style slender, straight. Stigmas two.

SPECIMENS EXAMINED

MAINE: Pittsfield, *Knight*, June 18, 1905 (K. M.); Mt. Hope, *Knight*, July 1, 1906 (K. M.); Orono, *Knight*, July 15, 1904 (K. M.).

MASSACHUSETTS: Middlefield, Hampshire County, *Fernald & Long 8991*, *8992*, June 26, 1913 (P.); North Adams, Berkshire County, *Fernald & Long 8990*, June 25, 1913 (P.); "Massachusetts, *Dewey*" (P.).

NEW YORK: Dundee, Yates County, *Wright* (K. M.); Lansingburgh, *Howe*, June, 1891 (N. Y.); Oneida County (C.).

NEW JERSEY: Netcong, Morris County, *Mackenzie 2078*, June 10, 1906 (K. M.).

PENNSYLVANIA: Ft. Washington, Montgomery County, *Long*, June 16, 1908 (P.).

DELAWARE: Vandyke, *Long 1742*, May 24, 1909 (P., K. M.).

MICHIGAN: Emerson, Chippewa County, *Dodge*, Sept. 5, 1914 (K. M.); Imlay City, Lapeer County, *Dodge*, June 11, 1911 (K. M.); Port Huron, *Dodge*, May 14, 1896 and May 28, 1896 (K. M.).

INDIANA: Bushrod, *Deam 10712*, May 26, 1912 (K. M.).

ILLINOIS: Fountaindale, Winnebago County, *Bebb* (P., K. M.).

SOUTH DAKOTA: Jones Island, *Williams 1876*, August 15, 1894 (K. M.).

NORTH DAKOTA: Butte, Benson County, *Lunell*, July 26, 1914 (K. M.); Lake Ibsen, Benson County, *Lunell*, July 4, 1914 (K. M.); Towner, McHenry County, *Lunell*, July 21, 1908, Sept. 10, 1908, June 12, 1913 (K. M.); Leeds, Benson County, *Lunell*, June 2, 1901 (K. M.).

NEW MEXICO: Brazos Canyon, Rio Arriba County, *Standley & Bollman 11036*, Sept. 1, 1914 (K. M.).

CAREX FESTUCACEA Schk.; Willd. Sp. Pl. 4: 242. 1805

Carex straminea var. *festucacea* Tuckerm. Enum. Meth. 18. 1843.

Densely cespitose, the culms slender but rather stiff, erect, 5–9 dm. high, sharply triangular and roughened on angles above, much exceeding leaves, the lower leaves reduced, the lower nodes not exposed. Leaves with well-developed blades three to five to a fertile culm, on lower third of culm, but not bunched, the blades flat, 1.5–2.5 mm. wide, usually 7.5–30 cm. long, the sheaths tight, sparingly septate-nodulose, conspicuously hyaline ventrally and prolonged upward. Inflorescence of four to ten spikes, in a moniliform head 2.5–6 cm. long, the spikes gynaecandrous, rounded at apex, 6–16 mm. long, 5–6 mm. wide, with ten to twenty appressed-ascending perigynia above with rather conspicuous tips, usually strongly clavate with numerous staminate flowers at base; lowest bract occasionally somewhat developed, the others scale-like. Scales ovate, acute, hyaline with green midvein, and tawny tinged, narrower and shorter than perigynia. Perigynia green or in age straw-colored, 3.5 mm. long, 2 mm. wide, the body orbicular, thick, plano-convex, winged to base, strongly about five-nerved dorsally over achene with an additional nerve in both margins, and similarly but less strongly nerved ventrally, rounded and sessile at base, abruptly contracted into a beak nearly length of body, the beak tawny-tipped, obliquely cut dorsally, flat and strongly serrulate as is upper half of perigynium body. Achenes oblong-ovoid, plano-convex, light-brown, short-stipitate, 1.5 mm. long, nearly 1 mm. wide, apiculate, the style slender, straight. Stigmas two.

SPECIMENS EXAMINED

MASSACHUSETTS: "Massachusetts," *B. D. Greene* (C.).

NEW YORK: Penn Yan, *Sartwell* (N. Y.).

NEW JERSEY: Farmingdale, Monmouth County, *Long &*

Brown 3601, May 28, 1910 (P., K. M.); Summit, Union County, *Mackenzie 159*, May 30, 1903 (K. M.); Monmouth Junction, *Mackenzie 4964, 4970*, May 26, 1912 (K. M.); Mt. Arlington, Morris County, *Mackenzie 1422*, June 25, 1905 (K. M.); Stirlington, Morris County, *Mackenzie 1268*, May 28, 1905 (K. M.).

PENNSYLVANIA: Valley Forge, Chester County, *Long*, June 24, 1909 (P.); Ryers, Philadelphia County, *Long*, June 15, 1909 (P.); Radnor Township, Delaware County, *Bartram*, June 10, 1907 (P.); Sellersville, *Crawford*, June 11, 1899 (P.); Byberry, *Martindale* (P.); Lanark, Lehigh County, *Pretz 4474*, June 1, 1912 (P.); Mountainville, Lehigh County, *Pretz 413*, June 15, 1907 (P.); Fern Rock, Philadelphia County, *Long*, June 13, 1908 (P.); Penllyn, Montgomery County, *Long 1703*, June 12, 1909 (P., K. M.); Corning, Lehigh County, *Pretz 3379*, May 21, 1911 (P.); New Garden, Chester County, *Pennell 4999*, June 12, 1913 (P.); Glen Riddle, Delaware County, *Pennell 3801*, June 23, 1912 (P.); Willow Grove, *Saunders*, June 4, 1898 (P.); Nottingham, Chester County, *Pennell & Long 7486*, June 22, 1912 (P., K. M.); "Pennsylvania," *Collins* (C.).

DELAWARE: Mt. Cuba, *Commons*, June 23, 1874 (P.); Faulkland, *Commons*, June 10, 1892 (P.).

MARYLAND: Beltsville, *Steele*, May 30, 1903 (K. M.).

NORTH CAROLINA: Salem, *Schweinitz* (P.).

TENNESSEE: Henderson, *Bain 10999*, May, 1893 (K. M.).

INDIANA: Hovey Lake, Posey County, *Deam 8303*, May 23, 1911 (K. M.); Bicknell, *Deam 11060*, June 7, 1912 (K. M.).

MISSOURI: Sheffield, *Bush 3904*, June 2, 1906 (K. M.); Sibley, *Mackenzie 88*, May 30, 1898 (K. M.); Independence, *Mackenzie*, May 23, 1897 (K. M.); Butler County, *Bush 2545*, May 1, 1905 (K. M.); Lake City, *Bush 6835*, June 20, 1912 (K. M.); Atherton, *Bush 6800*, June 7, 1912 (K. M.); Greenwood, *Bush 6707A*, May 20, 1912 (K. M.).

ARKANSAS: Texarkana, *Bush 2501*, April 28, 1905 (K. M.).

MISCELLANEOUS NEW SPECIES OF CAREX

Carex festivella sp. nov.

Cespitose from short-creeping tough matted blackish fibrillose root-stocks, the culms stout at base, slender but stiffish above,

3–6 dm. high, triangular and somewhat roughened beneath head, conspicuously striate, exceeding leaves, aphyllopodic, light brown at base, mostly developing and flowering same year. Leaves with well-developed blades three to five to a fertile culm, on lower fourth, but not bunched, the blades erect, 2–4 mm. wide, mostly 1–2 dm. long, flat, the sheaths tight, hyaline ventrally, concave at orifice. Sterile shoots similar. Head ovoid or oblong-ovoid, 12–25 mm. long, 10–18 mm. wide, with five to ten densely aggregated but distinct gynaecandrous spikes, the latter oblong-ovoid, 5–12 mm. long, 4–8 mm. wide, rounded or round tapering at base and round tapering at apex, the perigynia fifteen to thirty, densely arranged in many rows, appressed with erect ascending tips. Lowest bract somewhat prolonged, shorter than head, the others scale-like. Scales ovate, obtuse or acutish, dark chestnut to brownish-black with lighter poorly defined midvein and narrow hyaline margins, narrower and shorter than perigynia. Perigynia ovate, 3.75–5 mm. long, 1.5–2 mm. wide, thin, save where distended by achene, the walls membranaceous, light green or stramineous, the beak strongly dark-tinged, lightly several-nerved on both faces, rounded at base, strongly thin-margined, tapering into a beak half the length of body, serrulate to middle, the beak hyaline-tipped, obliquely cut ventrally. Achenes lenticular, obovoid, substipitate, 1.5 mm. long, 1 mm. wide, apiculate, the slender style tardily deciduous. Stigmas two.

The type specimens of *Carex festiva* Dewey were collected by Richardson "at Bear Lake and on the Rocky Mountains." These specimens or duplicates thereof marked as collected at Bear Lake are in the Torrey herbarium at the New York Botanical Garden, and represent a widely distributed boreal species known from the far northern regions of Canada, from Labrador, from Greenland and from various far northern points in Europe. Specimens which I cannot distinguish also come from the extreme southern part of South America, and associated with them is the name *Carex macloviana* D'Urv. This name has about ten years priority over *Carex festiva* Dewey, and accordingly must be used for the boreal plant under discussion.

This boreal plant is one representative of a series of closely related species, many of which are found in the higher mountains of the western part of North America. Taking these species together the tendency is rather strongly toward the development of a more congested inflorescence than is found in *Carex straminea*

and its numerous allies, so widely distributed especially in the eastern part of North America. This, however, is only a tendency, as a number of species of the *C. festiva* group, especially from California, have an elongated inflorescence; while on the other hand a number of species of the *C. straminea* group have a congested inflorescence.

Probably the best character to use to separate the two groups is that in the *C. festiva* group the beak of the perigynium towards the apex is slender and almost terete, and the margin for the last one or two millimeters is smooth or very sparingly serrulate. On the other hand in the *C. straminea* group the beak of the perigynium is flat and serrulate-margined to the tip.

For many years the name "*Carex festiva* Dewey" has been applied to specimens from the western mountains, and a plant especially common in Colorado and Wyoming has been taken to be the typical form. In this plant, which is the *C. festivella* of the present paper, the perigynium tapers into a dark slender beak half the length of the much lighter colored body and contrasting strongly with it in color. In the genuine boreal plant both body and beak are reddish tinged and the beak is only one fourth or one fifth the length of the body. In both species the extreme tip of the perigynium is hyaline. The Rocky Mountain plant is striate-nerved on the inner face; the boreal plant is essentially nerveless.

In addition to those characters taken from the perigynium it may be added that the boreal plant has reddish scales and the Rocky Mountain plant dark colored scales.

In the boreal plant the fertile culms develop several leaves the first year, and at flowering time in the second year these remain in a more or less dried-up condition at the base of the culms. As a result of this manner of growth there are always present numerous well-developed flowerless culms in a clump consisting of the first year fertile shoots and the more leafy sterile shoots.

In the Rocky Mountain plant the fertile culms normally develop all their leaves and flower during one year, and in consequence there are no old dried-up well-developed leaves towards the base of the flowering culms. At flowering time the shoots for the next year are very evident, but have no developed leaves. As

a result at flowering time the flowerless culms are few in number, consisting only of the sterile shoots. While this difference in manner of growth is very characteristic one must bear in mind that any unusual spell of warm weather towards the end of a season is apt to start into premature growth a shoot ready for quick development the next year. When this happens the result is the same biennial method of growth as in the boreal plant. While this is not of very frequent occurrence, it makes the use of this difference in habit of growth hardly useful as a key character.

For the group the Rocky Mountain plant under discussion usually has stout culms and broad leaf-blades and presents a very green general appearance. The closely allied *Carex microptera* Mackenzie has narrower perigynia which are very narrowly margined at base and have more spreading beaks giving the head an echinate appearance lacking in the present species.

Aven Nelson's No. 3275, collected July 2, 1897, in Albany County, Wyoming, and in my herbarium, may be taken as the type of *C. festivella*. A duplicate is in the New York Botanical Garden herbarium. The species ranges from the Cypress Hills in Saskatchewan and the Black Hills in North Dakota west to eastern British Columbia and southward through the Rocky Mountain region to Chihuahua, its best development being apparently in Colorado and Wyoming where it is one of the most characteristic mountain species.

SPECIMENS EXAMINED

CANADA: Between Keith and Columbia Rivers, *J. Macoun 63304*, July 8, 1902 (N. Y.); Banff, *J. Macoun*, July 12, 1891 (C.); Cypress Hills, Assiniboia, *J. Macoun 7397*, June 25, 1894 (C.); above Carbonate, *Petersen 225*, July 9, 1904 (N. Y.).

SOUTH DAKOTA: Rochford, Black Hills, *Rydberg 1087*, July 12, 1892 (N. Y.); Custer County, *Over 1768*, June 20, 1914 (K. M.).

MONTANA: Bozeman, *Rydberg 3002*, July 7, 1896 (N. Y.); Little Belt Mountains, *Flodman 305*, August 10, 1896 (N. Y.); Jocko Creek, *MacDougal 280*, June 16, 1911 (N. Y.); MacDougal's Peak, *MacDougal 601*, July 10, 1901 (N. Y.); Spanish Basin, *Rydberg & Bessey 3798*, June 28, 1897 (N. Y.); Aldridge, *Mrs. Scheuber 110*, 1901 (N. Y.); Elk Mountains, *Rydberg 3017, 3289*,

3342, 1896 (N. Y.); Long Baldy, Little Belt Mountains, *Rydberg 3395*, *3403*, August 20, 1896 (N. Y.); Bridger Mountains, *Rydberg & Bessey 3793*, June 14, 1897 (N. Y.); Little Belt Pass, *Rydberg 3340*, August 11, 1896 (N. Y.); Midvale, *Umbach 364*, July 13, 1903 (K. M.).

IDAHO: Victor, *Merrill & Wilcox 890*, July 10, 1901 (N. Y.); Beaver Cañon, *Shear 293* in part, June 26, 1895 (N. Y.).

WYOMING: Big Horn Mountains, *Tweedy 2237*, July, 1899 (N. Y.); Cliff Creek, *Curtis*, August, 1900 (N. Y.); Soda Butte Creek, *A. & E. Nelson 5869*, July 14, 1899 (N. Y.); Green Top, *Nelson 3255*, June 29, 1897 (N. Y.); Medicine Bow Range, *Kemp*, June, 1902 (N. Y.); Big Horn Mountains, *Tweedy 2238*, August, 1899 (N. Y.); Chug Creek, Albany County, *Nelson 7336*, June 29, 1900 (N. Y.); Pole Creek, Albany County, *Nelson 1926*, June 13, 1896 (N. Y.); Encampment, Carbon County, *Tweedy 4318*, *4323*, July 12, 1901 (N. Y.); Centennial Valley, Albany County, *A. Nelson 3275*, July 2, 1897 (N. Y., K. M.); Battle Lake, *A. Nelson 4012*, August 16, 1897 (N. Y., K. M.); Indian Grove Mountains, *E. Nelson 4899*, July 18, 1898 (N. Y.); Laramie, *A. Nelson 288*, June 28, 1894 (C.); La Plata Mines, *A. Nelson 1786*, August 22, 1895 (C.); Welcome, *Williams*, July 26, 1897 (K. M.); Big Horn Mountains, *Buffum 5012*, August 1, 1892 (K. M.); Carbon County, *A. Nelson 3996*, 1897 (K. M.); Sand Creek, *Williams 2689*, July 26, 1897 (K. M.); Rattlesnake Gulch, *Williams*, July 26, 1897 (K. M.); Albany County, *A. Nelson 3255*, 1897 (K. M.); East De Lacy's Creek, *Rydberg & Bessey 3791*, August 10, 1897 (N. Y.); Swan Lake, *Mearns 3302*, August 16, 1902 (N. Y.); *Edith A. Ross*, July, 1890 (N. Y.).

COLORADO: La Plata Cañon, *Baker, Earle & Tracy 699*, July 11, 1898 (N. Y.); Dolores, *Crandall*, June 18, 1892 (N. Y.); Pass Creek, *Rydberg & Vreeland 6453*, June 30, 1900 (N. Y.); *State Agricultural College Distribution 2547*, July 30, 1899 (N. Y.); *Baker*, July 12, 1899 (N. Y.); Crystal Park, *Bessey*, July 23, 1894 (N. Y.); Bob Creek, *Baker, Earle & Tracy 731*, June 28, 1898 (N. Y.); Sangre de Christo Creek, *Rydberg & Vreeland 6452*, June 22, 1900 (N. Y.); West Indian Creek, *Rydberg & Vreeland 6451*, June 14, 1900 (N. Y.); Pagosa Peak, *Baker 231*, August, 1898 (N. Y.); Cascade Cañon, *Bessey*, July 12, 1895 (N. Y.);

Rocky Mountains, *Hall, Olney distribution* (N. Y., K. M.); Silver Plume, *Rydberg 2462*, August 24, 1895 (N. Y.); Northern Colorado, *Tweedy 4319*, July 2, 1901 (N. Y.); Glen Haven, *Johnston 724*, August 8, 1910 (N. Y.); Mt. Richtophen, *State Agricultural College distribution 2542*, August 7, 1899 (N. Y.); Mt. Carbon, *Nelson 78*, July, 1909 (N. Y.); Clear Creek, *Parry 391*, 1861 (C.); Mt. Carbon, *Eggleston 5883*, July 6, 1910, and *5924, 5904*, July 9, 1910 (K. M.); Kebler Pass, *Eggleston 6168*, August 22, 1910 (K. M.); Summit County, *Mann*, July, 1899 (K. M.); Breckenridge, *Mackenzie 158*, August, 1901 (K. M.).

UTAH: Dyer Mine, Uintah Mountains, *Godding 1309*, July 9, 1902 (N. Y.); and *1354*, July 14, 1902 (N. Y.); Fish Lake, *Jones*, August 6, 1894 (N. Y.); Fish Lake, *Rydberg & Carlton 7520*, August 10, 1905 (N. Y.); Twin Creeks, *Rydberg & Carlton 7652*, August 8, 1905 (N. Y.); Big Cottonwood Cañon, *Rydberg 6816*, July 8, 1905 (N. Y.); Big Cottonwood Cañon, *Rydberg & Carlton 6627*, July 4, 1905 (N. Y.); Big Cottonwood Cañon, *Rydberg & Carlton 6395* in part, June 28, 1905 (N. Y.); Alta, Wahsatch Mountains, *Jones 1095*, July 29, 1879 (C.); Unionville, *Watson*, June, 1865 (C.); Cottonwood Cañon, *Watson 1235*, July, 1869 (C.).

NEVADA: Summit Lake region, *Griffiths & Morris 325*, July, 1901 (N. Y.).

NEW MEXICO: Bartlett Ranch, Colfax County, *Wooton*, September 4, 1913 (K. M.); Mogollon Mountains, *Metcalfe 287*, July 20, 1903 (N. Y.); Pecos River National Forest, *Standley 4131*, July 1, 1908 (N. Y., K. M.); Santa Rita Creek, *Thurber 151*, 1851 (N. Y.); Copper Mines, *Bigelow*, as *C. Hoodii* (N. Y., C.); Santa Rita del Cobra, *Bigelow*, as *C. Douglasii* (N. Y., C.); Brazos Cañon, *Standley & Bollman 10909, 11039*, 1914 (K. M.).

CHIHUAHUA: Sierra Madre, *Pringle 1402*, November 3, 1887 (C.).

Carex Egglestonii sp. nov.

In dense clumps, the culms 4.5–7.5 dm. high, stiffly erect, rather stout, aphyllopodic, light brownish at base, exceeding leaves, roughened on angles beneath head. Leaves with well-developed blades four to six to a fertile culm, on lower third, but not bunched, the overlapping sheaths conspicuously white-hyaline opposite the blades, the blades flat, 2–5 mm. wide, usually 1–2 dm. long, not long attenuate; head ovoid, 18–24 mm. long and

somewhat narrower, containing three to six closely aggregated but readily distinguishable gynaecandrous ovoid or ovoid-oblong spikes 10–14 mm. long, 6–10 mm. wide, rounded or short-pointed at apex, the lateral rounded and the terminal one short-tapering at base, the numerous perigynia appressed-ascending in many ranks with rather conspicuous tips, the staminate flowers few and inconspicuous; lowest bract short-prolonged, 6–18 mm. long, or scale-like, the others scale-like; scales ovate or ovate-lanceolate, acutish to short acuminate, chestnut brown with lighter midvein and conspicuous white-hyaline margins, narrower and markedly shorter than perigynia; perigynia olive-green or in age brownish, ovate, 6 mm. long, 3 mm. wide (widest near top of achene), thin except where distended by achene, strongly winged, slenderly nerved on both faces (nearly obsolete in age), rounded and sessile at base, abruptly contracted into a broad flat bidentate non-hyaline slightly colored beak 1.5 mm. long, winged and serrulate to the tip, the teeth strictly erect and contiguous but distinct; achenes lenticular, obovoid-oblong, thickish, substipitate, 2 mm. long, 1.25 mm. thick, short-pointed; style slender, not enlarged at base; stigmas two.

This handsome species of the western mountains is a member of the *Ovales*, and is probably most closely related to *Carex brevior* (Dewey) Mackenzie (see page 605). The type specimen is in the National Herbarium, and was collected by Mr. W. W. Eggleston (No. 6181), at Kebler Pass, Mt. Carbon, Gunnison County, Colorado, August 22, 1910.

SPECIMENS EXAMINED

COLORADO: West Mancos, *Baker, Earle & Tracy 322*, 9500 ft. alt., July 4, 1908 (N. Y.); Kebler Pass, Mt. Carbon, Gunnison County, *Eggleston 6181*, 3120 m. alt., August 22, 1910 (N., N. Y.); Ohio Peak, Gunnison County, *Eggleston 5905* in part, 2900 m. alt., July 9, 1910 (N. Y.).

UTAH: La Sal Mountains, *Rydberg & Garrett 8753, 8754, 9028, 9029, 9075, 9076*, July, 1911 (N. Y.); Abajo Mountains, *Rydberg & Garrett 9771, 9845*, August, 1911, 2500–3700 m. alt. (N. Y.); Uintas, *Watson 1239*, 10,000 ft. alt., July, 1869 (C.).

WYOMING: La Plata Mines, *E. Nelson 5150*, August 25, 1898 (N. Y.).

Carex Lunelliana sp. nov.

Cespitose from short-creeping dark colored woody fibrillose rootstocks, the culms 3–6 dm. high, aphyllopodic, stout, 5–8 mm.

wide at base, rather stiff, sharply triangular, roughened above, equalling or exceeding leaves, light brown at base. Leaves with well-developed blades four to six to a fertile culm, on lower half, not bunched, the sheaths conspicuously septate nodulose dorsally, tardily breaking, truncate and but slightly colored or thickened at mouth, the blades light green, flat, 4–8 mm. wide, mostly 1–2 dm. long. Head ovoid or oblong-ovoid, dense, 1–3 cm. long, 8–15 mm. wide, containing six to twelve androgynous spikes, the lower only distinguishable. Lower bracts at least setaceous prolonged, usually shorter than the head. Spikes with five to fifteen ascending or at maturity spreading perigynia, the apical staminate flowers inconspicuous. Scales ovate, tawny tinged with three-nerved green center, acuminate, cuspidate or short awned, narrower and usually shorter than perigynia. Perigynia plano-convex, 4.25 mm. long, 3.5 mm. wide, the body orbicular, greenish, straw-colored, or at maturity light yellowish-brown and rather shining, nerveless ventrally, several nerved dorsally, sharply smooth-margined nearly to the round-truncate somewhat spongy base, the margins green, not raised, the body somewhat abruptly contracted into a strongly bidentate serrulate beak, one fourth its length. Achene lenticular, filling perigynium, 2 mm. long and as wide, brownish yellow, minutely apiculate, jointed with the deciduous style, the latter with much enlarged base. Stigmas two.

A fine series of specimens collected by Dr. J. Lunell of Leeds, North Dakota, has called to my attention the fact that *Carex gravida* Bailey has been made to cover two distinct species, the more northern plant on which the species was based being different from the southern one. Genuine *Carex gravida* has the perigynia nerveless on both sides or faintly nerved dorsally, the body of the perigynium is ovate and tapers into the beak, and the scales are mostly awned. The southern plant, which has been confused with *C. gravida*, has perigynia strongly nerved dorsally, the body of the perigynium is orbicular and contracted into the beak, while the scales are cuspidate rather than awned. It gives me pleasure to name this plant in honor of Dr. Lunell, who has done so much towards making the flora of North Dakota better known.

SPECIMENS EXAMINED

MISSOURI: Oak Grove, *Bush 7020*, June 2, 1913 (type in Herb. K. M., duplicate in Herb. N. Y. Bot. Garden); Greenwood, *Bush 6709*, May 20, 1912 (N. Y., K. M.); Lees Summit, *Mackenzie*,

June 6, 1897 and May 28, 1899 (K. M.); Levasy, *Bush 1694*, May 18, 1902 (N. Y., K. M.); Grain Valley, *Bush 6984*, May 24, 1913 (K. M.); St. Louis, *Glatfelter*, May 17, 1894 (K. M.); St. Louis, *Eggert*, June 14, 1893 (C.).

KANSAS: Osborne County, *Shear 33*, May 19, 1894 (N. Y.).

OKLAHOMA: Sapulpa, *Bush 939, 945, 1005*, May, 1895 (C.).

✓ **Carex bulbostylis** sp. nov.

Carex grisea var. *globosa* Bailey; A. Gray, Man. Ed. 6, 605 (at least in part). 1890.

Cespitose, the rootstocks short, hard, rather slender, the culms 2–3.5 dm. high, central and lateral, slender, erect or ascending, obtusely triangular, smooth or nearly so, strongly purplish tinged at base, exceeding leaves but exceeded by bracts; sterile shoots elongated. Leaves with well-developed blades four to ten to a culm, the blades flat with revolute margins 2.5–3.5 mm. long, mostly 1–2 dm. long, or up to 3 dm. on sterile shoots, the sheaths smooth or nearly so. Staminate spike apparently long-peduncled (actually nearly sessile, the uppermost pistillate spike being abortive and with short sheathing bract), 2–3 cm. long, 2.5–3.5 mm. wide, the scales obovate-oblong, whitish with green slightly excurrent midrib, reddish brown tinged. Developed pistillate spikes three or four, the lower on erect rough peduncles, the upper scarcely exsert-peduncled, three- to seven-flowered, oblong or suborbicular; bracts leaf-like, strongly sheathing. Scales broadly ovate, white-hyaline and reddish-brown tinged, with green midvein excurrent as long cusp, the body narrower than and about half length of perigynia. Perigynia broadly obovoid, globose in cross-section, 4.5 mm. long, 2.5 mm. wide, finely many striate, green, minutely hispidulous when young, rounded at base and apex. Achenes obovoid, triangular, 3 mm. long, 2 mm. wide, yellowish, tapering to a substipitate base, minutely apiculate, jointed with conspicuously enlarged bulbous base of very short deciduous style; stigmas three, short.

The conspicuously enlarged style-base is the best technical character to separate this species from its allies, *Carex grisea* Wahl. and *Carex amphibola* Steud. The culms are strongly purplish tinged at the base, in this differing from *Carex grisea*. The short and proportionately broader perigynia also serve to distinguish it from that species, and still more so from *Carex amphibola* Steud.

SPECIMENS EXAMINED

TEXAS: Dallas, *Reverchon 2422*, April 13, 1901 (K. M.); also *2419*, March 26, 1901 (K. M.); also *2423*, May 2, 1901 (K. M.); also *2416A*, April 16, 1901 (N. Y., K. M.); Fort Worth, *Ruth 360*, April 12, 1913 (type in Herb. K. M.); Tarrant County, *Ruth 451*, April 4, 1914 (K. M.); Austin, *Rugel* (C.).

Carex onusta sp. nov.

Cespitose from short, fibrillose rootstocks, the culms aphyllopodic, 2–3.5 dm. high, stiff, but rather slender, bluntly triangular below, sharply triangular and roughened above, exceeding leaves, brownish at base. Leaves with well-developed blades three or four to a fertile culm, the sheaths tight, inconspicuously septate nodulose, cross rugulose ventrally and thickened at mouth, the blades green, flat, 2.5–3.5 mm. wide, mostly 1–2 dm. long. Head oblong or oblong-ovoid, dense, 8–13 mm. wide, 1.5–3 cm. long, containing eight to fifteen androgynous spikes, the lower only readily distinguishable. Lower bracts setaceous, shorter than head, the upper scale-like. Spikes with five to fifteen appressed or at length spreading or ascending perigynia, the apical staminate flowers usually forming a conspicuous but short cone. Scales ovate, cuspidate, hyaline, yellowish-brown tinged with green midvein, narrower than and about two thirds length of body of perigynia. Perigynia plano-convex, or slightly bi-convex, 3 mm. long, 1.5 mm. wide, oblong-ovate, green or in age yellowish, nerveless ventrally, obscurely few-nerved dorsally, sharply margined to the rounded non-spongy base, abruptly beaked, the beaked 0.75 mm. long, bidentate, serrulate. Achene plano-convex, filling perigynia 2.5 mm. long, 1.4 mm. wide, minutely truncately apiculate, the style short with much enlarged base. Stigmas two.

The perigynia strongly resemble those of *Carex Leavenworthii* Dewey and the scales are short, as in that species. The heads, however, are elongated, as in *Carex Muhlenbergii* Schk. The thin yellowish-brown tinged scales are peculiar and characteristic.

The type, collected by Professor Albert Ruth, No. 458, on April 24, 1914, in sandy woods in Tarrant County, Texas, is in my herbarium. These specimens are in most excellent condition.

Carex Sheldonii n. sp.

Tufted, strongly stoloniferous, the stolons stout. Culms phyllopodic, 7.5 dm. high, glabrous, obtusely angled and very smooth below inflorescence, exceeding the elongated leaves,

neither colored nor fibrillose at base; leaves with well-developed blades about four to a fertile culm, on lower half, not bunched, the sheaths and surfaces of blades (especially lower) sparsely short-pubescent, the hyaline part of sheaths dark-tinged at edge, the blades flat, 5–6 mm. wide, 2–4 dm. long (or on sterile culms much longer), rough towards apex, the basal sheaths breaking and slightly filamentose; staminate spikes two or three, separate from each other and widely separate from the pistillate, the upper peduncled, the others sessile, linear, 2.5–3.5 cm. long, 3 mm. wide, the bract of lowest conspicuous, the scales oblanceolate, acute, erose but not ciliate at apex, in age straw-colored and hyaline; pistillate spikes two, widely separate, erect, sessile or short exsert-peduncled, oblong-cylindric, 2–5 cm. long, 8–10 mm. wide, the perigynia twenty-five to sixty, ascending in several to many ranks, closely packed or the lower somewhat loosely arranged; bracts leaf-like, the lower sheathing and exceeding inflorescence, the upper smaller, nearly sheathless; scales ovate-lanceolate, acuminate or cuspidate, green and strongly several-nerved in center, with margins hyaline and usually with intermediate brownish tinged zone, narrower and shorter than perigynia; perigynia lanceolate, 5–6 mm. long, about 2 mm. wide, obscurely triangular, little inflated, short pubescent, prominently about fifteen-nerved, tapering into the bidentate beak 2 mm. long (including teeth), the teeth short, less than 1 mm. long, slightly spreading; achenes triangular, oblong-obovoid, 2.25 mm. long, 1.25 mm. wide, stipitate; style slender, straight, not enlarged at base; stigmas three.

One of the most conspicuous features of the eastern *Carex trichocarpa* Muhl., with which the present species has been confused, is the bright purple coloring of the sheaths opposite the blades, especially at the mouth. In addition the sheaths are glabrous or at most hispidulous and do not normally break open and become filamentose. In the present species the sheaths entirely lack this purple coloring, are soft pubescent at least at the mouth and do not readily break open. In *Carex laeviconica* Dewey (a species with glabrous perigynium and impressed nerves) the purple coloring is also lacking, but the glabrous sheaths quickly break open and become filamentose. *Carex atherodes* Spreng. with glabrous very deeply bifurcate perigynia has soft pubescent sheaths which break open readily and are brownish or purple tinged.

SPECIMENS EXAMINED

OREGON: "Along Clark's Creek, about three miles above mouth. Altitude 3,140 ft.," *E. P. Sheldon 8854*, September 9, 1897 (type in Herb. K. M., duplicate in Herb. N. Y. Bot. Garden); Crow Creek, Wallowa County, 4,300 feet alt., *E. P. Sheldon 8428*, June 29, 1897 (N. Y., K. M.); ditch sides of Malheur River, *Cusick 2549*, June 7, 1901 (N. Y.).

IDAHO: House Creek, Owyhee County, *Nelson & Macbride 1826*, June 30, 1912.

CALIFORNIA: "Jess Valley to Blue Lake," *Griffiths & Hunter 429*, August, 1902 (N. Y.).

Carex exserta sp. nov.

Carex filifolia var. γ *erostrata* Kükenth.; Engler's Pflanzenreich 4^{20}: 86. 1909. Not *Carex erostrata* Boott.

Very densely cespitose, the culms very slender and wiry, 5–25 cm. high, obtusely triangular, smooth, equalling or exceeding leaves, brownish, the basal sheaths filamentose. Leaves with well-developed blades two to four to a fertile culm, clustered above base, acicular, channelled, little roughened towards apex, 0.25–0.5 mm. wide, 1–10 cm. long, the sheaths tight, hyaline ventrally. Spike solitary, androgynous, 7–15 mm. long, the staminate part half or more length of whole, the scales reddish-brown, obovate, obtuse, minutely hyaline margined, the pistillate part up to 6 mm. wide with two to twelve ascending perigynia, the scales orbicular-ovate, obtuse, dull reddish brown with hyaline margins, exceeded by ripe perigynia. Bract scale-like or slightly developed. Perigynia obovoid, obtusely triangular, 2–5 mm., nearly 2 mm. wide, rounded at base and apex, nerveless, but obscurely two-ridged, essentially beakless, papillose-puberulent, brownish tinged, hyaline and obliquely cut at mouth. Achenes triangular, obovoid, closely filling perigynia, sessile brownish, 2 mm. long, apiculate, jointed with the very short, black exserted style. Stigmas three. Racheola conspicuous.

This characteristic Californian species differs constantly from the more eastern and northern *Carex filifolia* Nutt. in the essentially beakless perigynia and the duller colored scales. The style although very short is exserted, black and conspicuous.

The following specimens have been examined, all from the Sierra Nevada of California, at elevations between 1,500 and 3,500 meters:

summit of Morro Pass, *Brewer 1733*, June 27, 1863 (Cal.); Soda Springs of Tuolumne, *Brewer 1697*, June 26, 1863 (Cal.); Black Mountain, Fresno County, *Hall & Chandler 616*, July, 1900 (Cal.); Ebbett's Pass, *Brewer 2029*, August 3, 1863 (Cal.); Big Trees, *Hillebrand 2318* (Cal.); Echo Lake, El Dorado County, *Brainerd*, July 11, 1897 (Cal.); Mt. Lyell, *Hall & Babcock 3581*, July, 1902 (Cal.); Kings River, *Lemmon*, July, 1902 (Cal.); Yosemite, *Abrams 4600*, July, 1911 (K. M.); Little Yosemite, *Jepson 4396*, July 11, 1911 (K. M.); Harrison Pass, *Jepson 5035*, July 16, 1912 (K. M.); Cold Creek, Yosemite, *Jepson 4493*, July 22, 1911 (K. M.).

Carex rugosperma sp. nov.

"*Carex umbellata* Schkuhr," Mackenzie, Bull. Torrey Club 40: 551. 1913.

A careful study of Schkuhr's plate of *Carex umbellata* has thoroughly convinced me that what he had was the plant with short-beaked perigynia, named *Carex abdita* by Mr. Bicknell.* The plant with the long-beaked perigynia is in consequence without a name. A specimen collected by me at Tuckerton, New Jersey, in May, 1911, and in my herbarium, may be designated as the type of the above species.

* Bull. Torrey Club 35: 492. 1908.

On the characters and relationships of the genus Monopteryx Spruce*

HENRY PITTIER

(WITH TWO TEXT FIGURES)

The name *Monopteryx* was applied by Spruce to a papilionaceous tree of the upper Río Negro, in the forest region along the boundary between Brazil and Venezuela. The name evidently refers to the broadly developed upper pair of calyx teeth, which completely enclose the floral bud and are conspicuous in the open flower. In the notes on Spruce's travels, edited by the late Alfred Russell Wallace, there are two references to this genus: The first, accompanied by a well-drawn sketch, gives the size of *M. angustifolia* Spruce and describes its strongly developed buttresses, for which the native name "sapopema," i. e. flat root, is proposed;† the second assigns the other species, *M. Uaucu* Spruce, to a place among the oil-yielding trees of Equatorial America.

The first diagnosis of the genus, accompanied by description of the two species, was given by Bentham in Martius' Flora Brasiliensis.‡

The main generic characters were found in the short, subbipartite calyx, with large upper lip formed by the union of the two anterior lobes, and in the almost obsolete lower lip, entire or obscurely tridentate, and exterior in the bud. Furthermore the petals were stated to be sessile and almost equal in length to the calyx, and the ten stamens to be free, with basifixed anthers. The stipitate ovary, surmounted by a short style, was described as uniovulate and the ovule as anatropous. Bentham supposed that the unknown legume was drupaceous, because the other affinities were with *Dipteryx*, notwithstanding which he placed the genus among the Sophoreae.

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* Published by permission of the Secretary of Agriculture.

† Notes of a Botanist on the Amazon & Andes 1: 20–23; 335, *f. 29*; 480 (concerning "sapopemas"). London. 1908.

‡ 15[1]: 307–309. *pl. 122*. 1862.

Among the plants collected by myself in Venezuela in 1913 there are specimens of flowers and fruits of a tree which undoubtedly belongs to Spruce's genus, but the study of this material shows clearly that Bentham's characterization of *Monopteryx* was drawn from immature flowers. It is indeed a very well-known fact that in most, if not in all, papilionaceous flowers the stamens are free in the bud. Moreover, the drawings of the other floral details in the plate referred to above give an impression of imperfect condition of the several parts, such as it is found when dissecting undeveloped flowers. In my Venezuelan specimens I found free stamens, sessile petals, etc. in alabastra on the point of opening, but the mature flowers (FIG. 1) showed very different characters.

FIG. 1. MONOPTERYX JAHNII Pittier. Flower. Natural size.

In the calyx (FIG. 2, *a*) no traces of the three inferior lobules are found, a detail which, however, does not necessarily contradict the observations made upon the other two species. But the petals (FIG. 2, *b*), more than twice as long as the calyx, are perfectly developed, the wings and carinal petals having claws about 2.5 mm. long and well-developed auricles. The ten stamens (FIG. 2, *c*) are united into a tube 6 mm. long, slit only at the base, and the carinal stamen is longer than the others; the anthers (FIG. 2, *c'*, *c''*), bicuspidate at base and tip, are dorsifixed; the short-stipitate ovary (FIG. 2, *d*) is just as often two- as one-ovulate; and the style is much more developed than the drawings in Bentham's plate would lead one to expect.

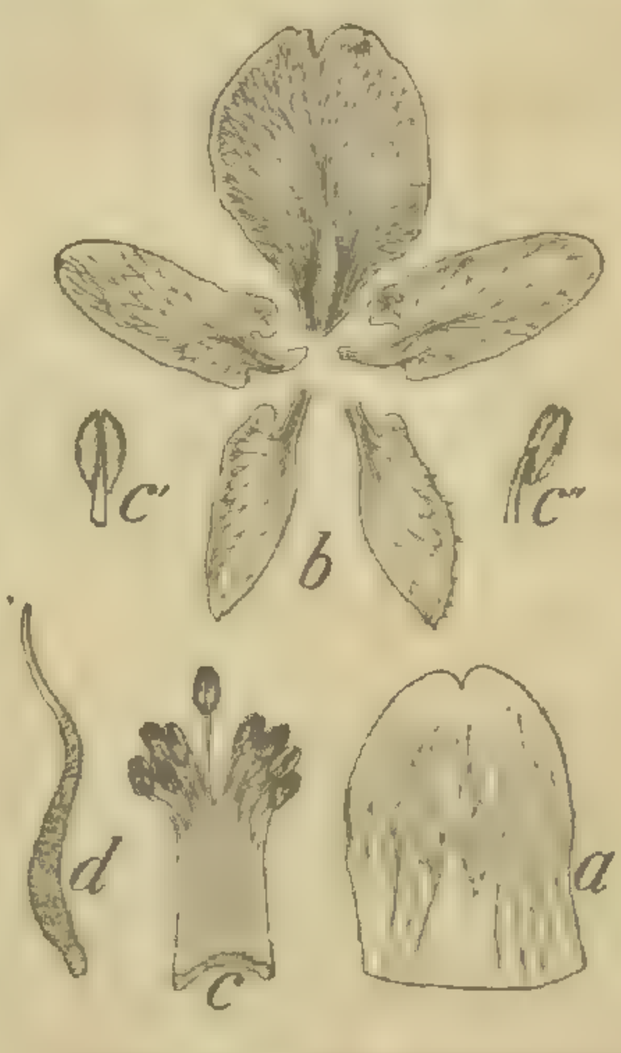

FIG. 2. MONOPTERYX JAHNII Pittier. *a*. Calyx split open. *b*. Petals. *c*. Staminal tube split open. *c'*. Stamen from the back. *c''*. Stamen from the side. *d*. Pistil. All natural size.

With reference to the fruit, there is a puzzling detail in the fact that Spruce stated that oil and a cheese-like substance were extracted from it. Considering the similarity in all structural particulars of the flowers of the Venezuelan tree and those of the two species known heretofore, they must necessarily be considered as congeneric; but on the other hand it is not readily seen how the small seeds of the former could attract the attention of the aborigines as an oil producer.

I should not be surprised, indeed, if the name *uacu* or *uaucu* had been misapplied, when used to designate a species of *Monopteryx*.

The fruits of the Venezuelan specimens are very much like those of all *Pterocarpus* species, the wing embracing the whole pod from its base to the end of the style, which, however, is on the median line and does not project outside the margin of the wing as in that genus. Besides, the seeds are apparently always single on the median line of the pod, while in *Pterocarpus* they are either single or in pairs, enclosed in a more or less orbicular pod, central to the wing.

In examining the leaves of my specimens I found on the main rachis, between the insertion of the lateral leaflets and at the base of the terminal leaflets, traces of glandular formations as mentioned by Bentham. In *M. angustifolia* the leaflets are distinctly alternate, whereas they are subopposite in my specimens; in *M. Uaucu* they are trifoliolate, and said to be opposite in the basal pair.

In the absence of the fruit and of perfectly developed stamens, the peculiar structure of the calyx as described above would justify the placing of the genus *Monopteryx* in the Geoffraeineae, with *Coumarouna* and *Pterodon*, with the difference that in the former the two broadly developed lobules are adnate. But with our present knowledge we are able to place it definitely in the Pterocarpinae and next to *Pterocarpus*.

The Venezuelan plant collected by me differs from both the species discovered by Spruce in several characters, for which reason it must be considered as new. From *Monopteryx angustifolia* it departs in having a larger number of leaflets (thirteen instead of nine), in the greater development of the inflorescence, and in the total absence of the three inferior teeth of the calyx. *Monopteryx Uaucu* is clearly differentiated by its three-foliolate leaves.

Following are the emended characteristics of the genus *Monopteryx* and a description of the new species, *M. Jahnii*.

MONOPTERYX Spruce em.

Calyx turbinatus, tubo breve subbipartito; labium superius (e laciniis 2 alte connatis) maximum, complicatum, emarginatum, florem ante anthesin includens, inferius obsoletum vel (e laciniis

3 connatis) aestivatione exterius, breve, acutum, integrum vel obscure tridentatum. Corolla papilionacea; petala unguiculata, calycis labium superius valde superantia. Vexillum obovatum vel suborbiculatum, emarginatum. Alae oblongo-cultriformes, biauriculatae, vexillo breviores. Carina subfalcata, vexillo brevior, petalis carinalibus dorso superne cohaerentibus. Stamina 10, monadelpha, inaequalia; antherae ovato-oblongae, dorso affixae, versatiles. Ovarium breve stipitatum, 1–2-ovulatum, stylo glabro, leviter arcuato, sub apice hinc stigmatoso. Legumen fusiforme, indehiscens, circumcirca late elliptico-alatum. Semen solitarium, depressum, elongato-naviculiforme, funiculo brevissimo.

Arbores Americae aequinoctialis, foliis alternis impari-pinnatis, foliolis coriaceis, petiolo inter foliola glandulifero. Racemi ad apices ramulorum paniculas laxas floribundas at parum ramosas formantes.

Genus *Pterocarpo* simile, sed differt calyce bipartito, labio superiore valde evoluto, inferiore obsoleto vel inconspicuo, et legumine fusiformi elliptico-alato nec orbiculato. Species 3, Brasiliae borealis et Venezuelae.

Monopteryx Jahnii Pittier, sp. nov.

Coma elongata, ramulis cano-pubescentibus, foliis 11–13-foliolatis, rhachide pilosulo longitudinaliter striato inter foliola glandulifero, foliolis alternis vel suboppositis, ovato- vel elliptico-acuminatis, basi rotundatis, acumine apiculatis, supra glabris subtus pallidioribus pilosulisque, petiolulis cano-pubescentibus, racemis simplicibus ad apicem ramulorum late paniculatis, rhachidibus pedicellisque leviter rufo-pubescentibus, bracteis delapsis, bracteolis ovato-acutis hirsutis caducissimis, ad basin et medium solitariis, ad calycem 2 oppositis suffultis, floribus longe pedicellatis, calyce minute rufo-pubescente, basi turbinato, labio superiore late evoluto emarginato, inferiore nullo, vexillo breve lateque unguiculato, emarginato, calyce multo longiore, glabro, ambito pallide roseo-flavido basi supra unguem macula purpurea notato, alis longe unguiculatis, cultriformibus, basi biauriculatis apice late rotundatis vexillo subaequantibus, carina subfalcata, petalis auriculatis longe unguiculatis alis angustioribus, margine superiore minute lanato-villoso, staminibus 10 monadelphis, inferiore superioribus longiore, ovario breve stipitato, 1–2-ovulato, villoso, stilo glabro apice truncato, legumine longe pedicellato, basi attenuato, late elliptico-alato, utrinque pubescente, semine depresso, anguste elongato, naviculiforme.

Arbor parva, decidua, 8–10-metralis, coma oblonga. Petiolus communis 19–25 cm. longa; foliola 6–11.5 cm. longa, 2.5–4.5 cm. lata; petioluli 4 mm. longi. Racemi usque ad 30 cm. longi, floribundi; pedicelli 8–9 mm. longi; calycis tubum circa 5 mm. longum, labio superiore 9 mm. longo; vexillum 13.5 mm. longum, 9.5 mm. latum; alae roseo-flavae, margine superiore paulo sinuata, 9 mm. longae, 3.5–3.8 mm. latae; stamina glabra 9–13 mm. longa; pistillum 17–18 mm. longum. Legumen (an maturum?) 5.5 cm. longum, 2.7 cm. latum.

VENEZUELA: Cárdenas Farm, Siquire Valley, State of Miranda, at an altitude of about 500 m., flowers and fruits, March 24, 1913 (*H. Pittier 6005*, type; U. S. Nat. Herb. Nos. 601729, 30).

I have named this species for my friend Dr. Alfred Jahn, a distinguished explorer, engineer, and botanist of Venezuela. Its local vernacular name is *tasajo*, a word used also to designate salt beef dried in the sun.

BUREAU OF PLANT INDUSTRY,
U. S. DEPARTMENT OF AGRICULTURE

Phytogeographical notes on the Rocky Mountain region
V. Grasslands of the Subalpine and Montane Zones

P. A. Rydberg

In a previous paper, I have discussed the forest trees of the mountains proper. Next to the trees the most important vegetation consists of the grasses. In fact, it may be said that in most cases where the land is not covered by the forest, the grasses are the predominant plants. The principal exceptions are the following: (1) Lakes and ponds, as the aquatic grasses are few and there are no aquatic trees. (2) Rock-slides and bare cliffs, where the soil is too scant. As soon as humus and sediments have had time to increase the soil, regions of this type will gradually change into either a forest-formation or a grassland. (3) Shrub formations. These are not very common in the mountains, but more so in the foothills. They are mostly found on the borders between the forest and the grassland, and in time will change into either, usually into the former. (4) Certain brook banks, especially in the subalpine region, where the vegetation consists of species of *Mertensia*, *Senecio*, *Delphinium* and other dicotyledonous plants.

Usually the forest occupies the slopes, while the grasslands occupy either the elevated ridges or so-called "hog-backs," or else the valleys or so-called "parks." The cause of this division is pointed out, or at least suggested, in one of my preceding papers on the alpine region.* The "hog-backs" are exposed to the desiccating winds and are therefore too dry for forest growths. In the valleys too much snow lodges during the winter and melts too slowly during the summer and the trees would be suffocated. There may also be other causes. In the valleys and parks, the drainage is often too poor and the soil has become too alkaline or saline for tree growth.

The grasslands are, however, not wholly confined to the ridges and valleys. In many places, the slopes where the soil and

* Bull. Torrey Club 40: 681, 682. 1913.

drainage are both good and where there is no special exposure either to wind or snow are occupied by grasses and not by forest. In such cases it is harder to point out the causes of the conditions. In some cases the forests have been destroyed by fires, and the grasses have gained possession of the ground before a reforestation had taken place.

A. SUBALPINE ZONE

The grasslands of the Subalpine Zone resemble much those of the Alpine Zone, which has been treated in a previous article. They are, however, of comparatively less extent, only covering larger areas in the more open valleys, where too much snow lodged, and along the wind-swept "hog-backs." The former are practically a continuation of the alpine meadows, the latter of the mountain crests. The grasses are mostly the same with some additions from the Montane Zone below. The grasses confined to the Subalpine Zone only are indeed very few.

Species in the following lists marked with an asterisk (*) are restricted to the lower parts of the zone; those marked with a dagger (†) to the upper part.

1. LAKES, PONDS, BROOKS and SWAMPS

Lakes or ponds are very rare in the Subalpine Zone; they are mostly situated in amphitheaters immediately under the snow fields and are usually filled with ice until late in the spring. They are almost void of higher vegetation, which is limited to a few species of *Sparganium* and *Potamogeton*. There are, as a rule, no grasses. The only aquatic grass in the upper part of the Zone is *Catabrosa aquatica*, which is usually confined to the mountain brooks in places where the current is less swift. In the lower part of the Zone is added to this *Panicularia pauciflora*, growing in willow bogs. Th ecommon water grasses of the lower mountain regions and the Great Plains are wanting: viz. *Phragmites*, *Spartina*, *Calamagrostis*, *Panicularia americana*, and *Phalaris*.

2. MEADOWS

The wet meadows are confined to the lower and moister parts of the open valleys. In the upper part of the Zone they are practically identical with the Alpine meadow-lands; in the lower

part a number of species from the Montane Zone are added. Along the water courses perhaps the most common grass in the upper part is *Deschampsia caespitosa*. Where the soil is richer the predominant grasses are *Phleum alpinum*, *Agrostis variabilis*, *Trisetum subspicatum*, *T. majus* and several species of *Poa*. In the lower part these, except the poas, are more or less replaced by *Alopecurus aristulatus*, *Muhlenbergia comata*, *Agrostis asperifolia*, *Graphephorum muticum*, and *Danthonia californica*. Among bushes, especially along the streams, the most common grasses are *Calamagrostis canadensis*, *C. Langsdorfii*, *Panicularia nervata*, and *P. pauciflora*. In the Northern Rockies many wet meadows are made up wholly of *Alopecurus occidentalis*, but this species is rare in the Southern Rockies.

The following grasses are found in the Subalpine Zone throughout the whole Rocky Mountain region:

**Muhlenbergia racemosa*
* " *comata*
**Phleum pratense*
" *alpinum*
**Alopecurus aristulatus*
" *occidentalis*
**Agrostis asperifolia*
" *hyemalis*
" *variabilis*
Calamagrostis Langsdorfii
" *canadensis*
**Deschampsia atropurpurea*
† " *curtifolia*
" *caespitosa*
Trisetum subspicatum
" *majus*
**Graphephorum muticum*
**Danthonia californica*
* " *intermedia*
Poa pratensis
" *reflexa*
" *leptocoma*
" *alpina*
* " *Olneyi*
* " *Vaseyana*
**Panicularia nervata*
" *pauciflora*
**Hordeum jubatum*

The following are restricted to one of the two divisions:

Southern Rockies

Muhlenbergia Wolfii
**Agrostis canina*
†*Deschampsia alpicola*
Graphephorum Wolfii
Poa callichroa
† " *pudica*
" *occidentalis*
* " *tricholepis*

Northern Rockies

Agrostis variabilis
Poa nervosa

The following mesophytic grasses, which could be counted among the meadow-grasses, prefer, however, river banks more or less covered by shrubbery.

Calamagrostis Langsdorfii
" *canadensis*
Trisetum montanum
**Elymus glaucus*

3. DRY VALLEYS AND BENCH-LANDS

Sometimes the sides of the valleys slope gently and the meadow passes gradually into the dryer part of the valley and this into the mountain side, sometimes the sides rise in a series of steps or shelves, one above the other. These steps are the remains of former river-banks or lake-shores. They are known as benches. The grasses of the bench-lands and other drier portions of the valleys are decidedly xerophytic. They consist mostly of genera which are characteristic of the Great Plains or the Foot-hills. In the Subalpine Zone the bench-lands are not often found and are always of insignificant area. The following grasses are characteristic of the bench-lands of the Subalpine Zone:

Stipa Tweedyi
" *minor*
Poa crocata
" *longiligula*
" *lucida*
" *Buckleyana*
Bromus Porteri
" *Richardsonii*
" *polyanthos*
Agropyron violaceum
Elymus simplex

4. MOUNTAIN SLOPES

Sometimes the meadow passes gradually into the mountain slopes, without any intervening xerophytic region. The mountain grass-slope is often mesophytic in its nature, especially in the Subalpine Zone, and is much like that of the Alpine Zone. In the Northern Rockies the most important grass of such mountain sides is *Festuca ingrata*, which, however, has its best development in the Montane Zone. This grass is also common in the northern part of the Southern Rockies, but on the southern slopes of the latter its place is taken by *Festuca arizonica* and *F. Thurberi*. The latter for instance covers all the southern slopes of the Abajo Mountains in southeastern Utah, almost to the top (3,300 m. alt.). These slopes, however, are more xerophytic than the mountain

sides of the Northern Rockies. The grass flora of the mountain sides is of the following composition:

Stipa minor
* " *Nelsonii*
Agrostis hiemalis
Trisetum subspicatum
" *majus*
Poa longiligula
" *paddensis*
" *epilis*
" *confusa*
" *laevigata*
Festuca ingrata
† " *saximontana*
Bromus Richardsonii
" *Pumpellianus*
Agropyron andinum
" *Scribneri*
" *violaceum*

The following are restricted to one region:

Southern Rockies

Muhlenbergia gracilis
" *subalpina*
Poa aperta
" *longipedunculata*
Poa Fendleriana
" *Sheldonii*
Bromus Porteri

Northern Rockies

**Poa Cusickii*
" *nevadensis*
†*Agropyron latiglume*

Southern slope of the Southern Rockies

On the more xérophytic southern slopes of the Rockies of Colorado and New Mexico, the following species are the characteristic ones:

Trichachne saccharatum
Poa crocata
" *Fendleriana*
Festuca arizonica
" *Thurberi*
† " *saximontana*

5. HOG-BACKS

As stated before, the grass flora of the hog-backs or exposed ridges is practically the same as that of the rock-crests of the alpine region, except that a few of the more mesophytic grasses, as for instance *Trisetum subspicatum* and *Deschampsia curtifolia*, are lacking. A few species from the Montane Zone are added.

The following species growing in both the Northern and Southern Rockies belong here:

Calamagrostis purpurascens
†*Poa rupicola*
" *crocata*
† " *Pattersonii*
" *epilis*
" *paddensis*
" *longiligula*
Festuca curtifolia
" *saximontana*
†*Agropyron Scribneri*
† " *andinum*

The following belong here also, but are restricted to but one region:

Southern Rockies	Northern Rockies
Muhlenbergia subalpina	*Poa confusa*
" *filiculmis*	" *Cusickii*
Festuca minutiflora	*Sitanion rigidum*

B. MONTANE ZONE

The grasslands of the Montane Zone resemble more those of the Great Plains and the Foothills. In the large open valleys or so-called parks, many of the grasses are the same as those found in the valleys of the plain region, in fact many have followed the streams up from the prairies. The grass flora of the bottoms of the canyons and of the river banks is also much the same as further down in the plain region. The flora of the elevated ridges and "hog-backs" also is more or less a continuation of that of the plains, with the addition of some endemic grasses. The grass flora of the mountain slopes consists more exclusively of grasses peculiar to the mountain regions.

Species in the following lists marked with an asterisk (*) are common to the Great Plains; those marked with a dagger (†), to the Subalpine Zone. Species marked with a double dagger (‡) are northern species found at low altitudes throughout the boreal regions but not on the Great Plains or the Prairies; in the Rocky Mountains they are restricted to the Montane and Subalpine Zones. Species marked with a section (§) occur also on the Staked Plains and in the Upper Sonoran region.

1. LAKES, PONDS AND SWAMPS

The water grasses are not many. *Catabrosa aquatica* is mostly confined to slow running brooks, *Phragmites Phragmites*, *Panicularia americana* and *P. borealis* are found in lakes and ponds mostly near the shore; so also are *Phalaris arundinacea*, *Agrostis asperifolia*, *Beckmannia erucaeformis*, and *Calamagrostis Langsdorfii*, but these prefer the bogs rather than the deeper water. The following belong to this formation:

Phalaris arundinacea
**Calamagrostis hyperborea*
Agrostis asperifolia
**Beckmannia erucaeformis*
‡†*Catabrosa aquatica*
**Phragmites Phragmites*
**Panicularia americana*
‡ " *nervata*
† " *pauciflora*
‡ " *borealis*

The following is restricted to the Northern Rockies:
Panicularia elata

2. MEADOWS

As in the Subalpine Zone the wet meadows are situated in the more open valleys, but they are here of greater extent, as the grade of the water courses is not so steep as in the higher regions. Many of the grasses are the same as those of the subalpine meadows and even some of the alpine species, such as *Poa alpina* and *Phleum alpinum*, are occasionally found along the water courses, where the ground is kept cool by the ice water from the mountains. Still more species are common to this and the valleys of the Foothills and the Great Plains. The genera of Aveneae, such as *Deschampsia*, *Trisetum* and *Graphephorum*, become more sparing, and those of Agrostideae, such as *Agrostis*, *Muhlenbergia* and *Calamagrostis*, more common. The tribe Hordeae, rarely represented in the subalpine meadow, becomes also more frequent, especially the genus *Hordeum* and the stoloniferous species of *Agropyron*. It is scarcely worth while to indicate the principal species, for in one meadow there might be one species predominant, in another there might be another species. In the Northern Rockies the predominant species in many places are *Alopecurus occidentalis*, *Agrostis alba*, *Phalaris arundinacea*, or *Festuca vallicola*, but in the Southern Rockies this is rarely if ever the case. Here the species of *Poa* are usually predominant. The following grasses inhabit the montane meadows:

**Phalaris arundinacea*
Muhlenbergia racemosa
" *Richardsonis*
* " *comata*
" *filiformis*
Phleum pratense
† " *alpinum*
**Alopecurus aristulatus*
" *occidentalis*
Agrostis alba
" *asperifolia*
" *tenuiculmis*
* " *hiemalis*
†Calamagrostis Langsdorfii
" *canadensis*
" *Scribneri*
* " *neglecta*
* " *hyperborea*
" *micrantha*
†Deschampsia caespitosa
†Trisetum majus
Graphephorum muticum
Danthonia californica
" *intermedia*
**Eatonia intermedia*
Melica spectabilis
" *bulbosa*
Poa pratensis
" *reflexa*
" *leptocoma*
* " *triflora*
† " *alpina*
" *Wheeleri*
" *Olneyi*
" *pratericola*
**Panicularia nervata*
" *pauciflora*
**Agropyron pseudorepens*
**Hordeum jubatum*
* " *nodosum*
" *boreale*

The following are also found in the meadows, but are restricted to one region:

Southern Rockies

**Muhlenbergia Wrightii*
Agrostis canina
**Calamagrostis inexpansa*
Graphephorum Shearii
Graphephorum Wolfii
**Poa interior*
" *tricholepis*
Agropyron Palmeri

Northern Rockies

Panicum pacificum
Muhlenbergia squarrosa
Agrostis humilis
" *aequivalvis*
" *variabilis*
Calamagrostis blanda
Calamagrostis laxiflora
**Eatonia pennsylvanica*
Poa nervosa
" *longipila*
Festuca vallicola

Certain species are limited to, or more common in, the more

alkaline meadows, which are quite wet in the spring but dry in the autumn. These are:

**Puccinellia airoides*	**Agropyron Smithii*
**Spartina gracilis*	* " *molle*
**Distichlis stricta*	* " *dasystachyum*
Elymus simplex	(Northern Rockies only)

A few species may be counted to the meadow flora, but they are found only in sandy places, on creek-banks, etc., and are limited to the Southern Rockies. These are:

Muhlenbergia simplex	*Muhlenbergia Wolfii*
" *aristata*	

The following meadow species are usually most common among shrubs:

Eatonia pennsylvanica	*Savastana odorata*
Panicularia nervata	*Oryzopsis micrantha*
" *pauciflora*	*Elymus glaucus*

So also the following, which, however, are restricted to one region:

Southern Rockies	Northern Rockies
Stipa Porteri	*Melica subulata*
Panicularia Holmii	*Panicularia elata*
Festuca fratercula	*Festuca elatior*

3. DRY VALLEYS AND BENCH-LANDS

The dry valleys and bench-lands are more common and of greater extent in the Montane Zone than in the Subalpine, and more common in the Northern Rockies than in the Southern. Except in the three parks of Colorado (Northern, Middle and Southern) they are also as a rule smaller in the Southern Rockies. The grasses are composed mainly of two elements, the species common to the Great Plains and those endemic to the mountains. In the drier parts of the valleys there are scarcely any high northern ones running south in the mountains. In the southern portion of the Southern Rockies, there are a few species

belonging to the Staked Plains and the Upper Sonoran flora. The species of *Andropogon*, *Sporobolus*, and *Koeleria* and the stoloniferous species of *Agropyron* are immigrants from the Great Plains, while those of *Stipa* (except *S. comata*) and most species of *Bromus* are endemic. The species of *Poa* and the bunched species of *Agropyron* are divided between the two categories. The following belong here:

**Andropogon furcatus*
** " Hallii*
**Stipa comata*
* " Tweedyi*
* " viridula*
* " Nelsonii*
* " minor*
**Muhlenbergia Richardsonis*
**Sporobolus airoides*
** " asperifolius*
** " chryptandrus*
**Bouteloua oligostachya*
Poa crocata
* " longiligula*
* " laevigata*
* " confusa*
** " pratericola*
** " Buckleyana*
**Koeleria gracilis*
Festuca campestris
Bromus polyanthus
‡ " *Richardsonii*
* " Pumpellianus*
‡*Agropyron violaceum*
** " tenerum*
‡ " *caninum*
** " pseudorepens*
** " Smithii*
** " molle*
* " spicatum*
**Hordeum jubatum*
**Sitanion elymoides*
Elymus triticoides
* " condensatus*
* " simplex*

The following also belong here but are restricted:

Southern Rockies

Andropogon chrysocomus
§*Blepharineuron tricholepis*
Poa lucida
Bromus Porteri
§*Festuca Thurberi*
§*Agropyron arizonicum*
§ " *Bakeri*

Northern Rockies

Stipa Richardsonii
* " Williamsii*
* " Elmeri*
Muhlenbergia squarrosa
Calamagrostis montanensis
Poa nevadensis
Bromus breviaristatus
* " Flodmanii*

Agropyron spicatum
" *Richardsonii*
* " *albicans*
Agropyron Gmelini
* " *dasystachyum*
Sitanion montanum

4. MOUNTAIN SLOPES AND HILLSIDES

The mountain slopes in the Montane Zone resemble closely those of the Subalpine Zone, but are more common and of greater extent. The number of species is much larger. As stated under the Subalpine Zone, the most important species in the Northern Rockies is *Festuca ingrata*, and its place is taken on the southern slopes of the Southern Rockies by *F. arizonica* and *F. Thurberi*. The following species are represented in both the Northern and the Southern Rockies:

**Stipa viridula*
" *Nelsonii*
" *minor*
" *Vaseyi*
Oryzopsis exigua
Agrostis hiemalis
†*Trisetum subspicatum*
† " *majus*
Poa longiligula
† " *epilis*
† " *paddensis*
" *laevigata*
†*Festuca saximontana*
" *ingrata*
" *confinis*
‡*Bromus Richardsonii*
" *Pumpellianus*
†*Agropyron andinum*
‡ " *violaceum*
* " *tenerum*
**Sitanion elymoides*
**Elymus canadensis*

The following are restricted to one region:

Southern Rockies

**Trichachne saccharatum*
Stipa Scribneri
Muhlenbergia gracilis
* " *subalpina*
Melica Porteri
Poa aperta
" *macroclada*
" *Fendleriana*
Poa longipedunculata
" *Sheldonii*
§*Festuca fratercula*
§ " *arizonica*
§ " *Thurberi*
Bromus lanatipes
" *Porteri*
§*Sitanion molle*

Northern Rockies

Stipa Richardsonii
" *Lettermannii*
Poa Cusickii
" *nevadensis*
Elymus innovatus
†*Agropyron latiglume*
" *spicatum*

5. HOG-BACKS AND DRY RIDGES

The flora here consists mostly of grasses from the Great Plains intermixed with some elements from the Subalpine Zone. The grass flora is rather poor in number of species. This is especially the case if those common to the hillsides are eliminated. The flora includes the following grasses:

**Aristida longiseta*
* " *Fendleriana*
Stipa viridula
**Calamagrostis purpurascens*
Avena americana
Danthonia intermedia
Bouteloua oligostachya
**Koeleria gracilis*
Poa crocata
† " *paddensis*
†*Festuca brachyphylla*
† " *saximontana*
†*Agropyron andinum*
† " *Scribneri*
" *spicatum*

The following are restricted to one region:

Southern Rockies

Stipa Vaseyi
†*Muhlenbergia subalpina*
" *filiculmis*
Poa Fendleriana

Northern Rockies

†*Poa Cusickii*
**Festuca campestris*
†*Sitanion rigidum*
" *lanceolatum*

To the preceding formations may be added the following five in which the grasses do not constitute the principal or predominant species:

6. WOODS

The truly wood species of grasses are very few, and even these do not grow in the deep forest but in more open places. They are the following:

Oryzopsis asperifolia
Cinna latifolia
Avena striata
Poa compressa
Festuca Jonesii

To these are added in the Northern Rockies:

Calamagrostis Suksdorfii *Deschampsia elongata*

7. COPPICES AND RIVER BANKS

The following prefer more or less shaded situations among bushes, or on river banks among willows, birches, or alders:

§*Savastana odorata*
Stipa Richardsonii
Oryzopsis exigua
" *micrantha*
Calamagrostis canadensis
" *Langsdorfii*
Sporobolus cryptandrus
Panicularia nervata
" *pauciflora*
Festuca elatior
Elymus glaucus

Limited to one region:

Southern Rockies	Northern Rockies
Trisetum montanum	*Deschampsia elongata*
Panicularia Holmii	*Panicularia elata*
Melica Porteri	*Melica subulata*

8. SAND-DRAWS AND SAND-HILLS

A few species characteristic of the sand-hill regions of Nebraska and Kansas enter the river valleys, growing on sandy river-banks, draws, and in bottoms of canyons. They are:

Panicum barbipulvinatum
Eriocoma cuspidata
Muhlenbergia pungens
Festuca octoflora
Sporobolus asperifolius
" *confusus*
" *cryptandrus*

To these are added in the Southern Rockies:

Bouteloua prostrata
Muhlenbergia Thurberi
" *gracillima*
Munroa squarrosa
Elymus ambiguus

9. HOT SPRING FORMATION

In the Northern Rockies, especially in the Yellowstone National Park, there are found many hot springs. The minerals held in solution in the hot water, mostly silicates, are deposited,

forming often large fields of deposits in the form of crusts, which in course of time often become broken up and form sand fields. These hot spring formations have a peculiar flora of their own. The grasses are not many, however, but at least two of them have, so far as the writer knows, never been found elsewhere. These are *Panicum thermale* and *Deschampsia pungens*. The former has been collected also around hot springs in California. Besides these *Spartina gracilis* and *Panicum barbipulvinatum* are common. These are plants from the Great Plains, the former frequent in alkaline meadows and the latter in sand-draws. Another plant although not a grass, but a sedge, may be mentioned here, viz. *Eleocharis thermalis*, growing in the pools below the springs with water even too hot for a comfortable bath.

10. RUDERAL REGIONS

A few of the ruderal grasses of the Great Plains and the regions east thereof have been found near dwellings, along roads, in fields and in waste places as high up as within the limits of the Montane Zone. These are:

Synthyrisma humifusum
Panicum capillare
" *barbipulvinatum*
Poa annua
Dactylis glomerata
Chaetochloa glauca
Polypogon monspeliensis
Avena fatua
Bromus hordeaceus
" *secundus*

NEW YORK BOTANICAL GARDEN

INDEX TO AMERICAN BOTANICAL LITERATURE

1912–1915

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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A plant from tropical South America.

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BULLETIN

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Notes on Trichomanes—I. The identity of Trichomanes pyxidiferum L.

MARGARET SLOSSON

(WITH PLATES 30 AND 31)

The genus *Trichomanes* as included by Linnaeus in his "Species Plantarum" contains eleven species of the genus as now understood, in addition to certain species now included in *Hymenophyllum* and *Davallia*. The first species mentioned is *Trichomanes membranaceum*. But Linnaeus had previously established the genus as a monotypic one based on Plumier's *pl. 86.** This plate represents *Trichomanes crispum*, which must thus be regarded as the type of *Trichomanes*.

Since Linnaeus's time many subdivisions of the genus have been made and some raised to generic rank. It is not proposed to enter into a discussion of the validity of these groupings in these "Notes." The genus *Trichomanes* is here referred to in its widest sense. Nor is it proposed to undertake a monograph of the genus or any of its subdivisions. To do so would be a somewhat tremendous undertaking, as those who have attempted to sort out even a few of the species will agree. The genus is in a chaotic state. The chief reason for this is the large number of descriptions of species that have been published without illustration. With plants of this nature, accurate figures of some sort accompanying specific descriptions are in many cases a necessity; it is often practically impossible to furnish a written description that will apply to one species and to one alone.

[The BULLETIN for November (42: 603–650) was issued December 11, 1915.]

* Gen. Pl. 20. 1737; also Hort. Cliff. 476. 1737.

In this state of affairs all attempts to fix upon the oldest name for any species of the genus, excepting Linnaean species, must be temporarily given up. We have first to see if the current idea of the plant may not be erroneous, and if the plant can be definitely pinned to a given name. During the last three years I have been fortunate enough to obtain for examination, mostly through the kindness of European botanists, types of various species, and to have had for comparison with such adequate plates of published species as do exist, a large collection of tropical American plants, including the collections at the New York Botanical Garden, and many specimens from the United States National Museum at Washington which Mr. William R. Maxon has kindly allowed me the privilege of examining. In these "Notes" photographs of these types will be published, and old plates reproduced side by side with photographs of herbarium specimens when it appears that the identity of any species has been misunderstood and can be definitely fixed upon in this way. This should give part of a foundation for a future revision of the genus. Photographs, when sufficiently enlarged, do not mislead. A beginning in this direction has already been made by others. The most notable instance is Dr. Carl A. M. Lindman's excellent paper, "Remarks on Some American species of *Trichomanes* sect. *Didymoglossum* Desv.",* which may well serve as a model. Dr. Lindman's fine illustrations are drawings made by the aid of a camera lucida, not photographs, but I have preferred photography as sometimes bringing out characters the eyes may overlook.

The subject of the present paper is the identity of *Trichomanes pyxidiferum* L.

Linnaeus's description of this species reads as follows:†

> "*pyxidiferum* 5. TRICHOMANES frondibus sub-bipinnatis: pinnis alternis confertis lobatis linearibus.
> Filix pyxidifera. *Plum. fil.* 74. *t.* 50.
> Dareae tunbrigensis facie. *Pet. fil.* 104. *t.* 13. *f.* 13.
> *Habitat in* America."

Plumier's plant was from Santo Domingo. The locality of

* Ark. Bot. 1: 7–55. 1903.
† Sp. Pl. 1098. 1753.

Petiver's is not stated, except as America, but his figure points unmistakably to the same plant as Plumier's.

This species has been variously interpreted, no doubt often correctly, but probably the most common idea of it is that based on Hedwig's plate* and description. These represent a distinct easily recognizable and common tropical American species, but a recently received specimen of quite another plant from Santo Domingo makes it appear that the latter must bear the Linnaean name. A leaf of this plant, collected on rocks near Constanza, at an altitude of 1,250 meters, March 19, 1910, by H. von Tuerckheim, No. 3069, is figured on PLATE 30, FIG. 2, together with a reproduction of a leaf from Plumier's plate, FIG. 1. It will be seen that the most notable characteristics of the two leaves, the flexuose rachis, the stiff short wide pinnae, and especially the conspicuously short broad almost inflated indusium, appear in both.

This is the plant described by Christ as *Trichomanes junceum*.† His type is from Costa Rica, collected by Wercklé, and specimens so collected, from Christ's Herbarium and now in the Underwood Herbarium at the New York Botanical Garden, agree exactly with the Von Tuerckheim plant. Two leaves from these Costa Rican plants are figured on PLATE 30, FIG. 3.

Christ cites also *Pringle 3800* from Mexico, and a leaf from this number, collected on "faces of damp rocks, Tamasopo Canyon, State of San Luis Potosi, 17 July, 1891," is figured on PLATE 30, FIG. 4, as showing a still more marked resemblance to the Plumier plate. Christ's description of his plant is reprinted below. It will be seen that his idea of *Trichomanes pyxidiferum* is of quite a different species, exactly what does not appear, but most likely the plant of Hedwig's.

"8. Trichomanes junceum n. spec., typ. in Herb. Christ.

"E sectione *T. pyxidiferi* L.

"Differt ab illo statura rigida valde elongata contorta, laciniis angustissimis, urceolis minimis recte patentibus sive recurvis. Habitu Cystosirae angustissimae comparandum, colore nigrescente.

"Rhizomate repente duro 3 mm. lato squamulis patentibus nigris dense vestito, stipite basi incrassato iisdem squamulis ves-

* Filices Gen. et Sp. *pl.* 3. *f.* 2 *and c.* 1799.

† Bull. Boiss. II. 4: 944. 1904.

tito, 3 ad 4 cm. longo filiformi sed rigido, laminae rachi 10 cm. longa flexuosa, lamina lanceolata pinnis adscendentibus linearilanceolatis ad 4 cm. longis iterum pinnatis laciniis linearibus ⅔ mm. latis apice furcatis acutis nervo inconspicuo, urceolis ad basin laciniarum, brevissime pedunculatis patulis sive recurvis 1½ mm. longis anguste conicis vix 1 mm. latis, limbo statu maturo horizontaliter patente receptaculo exserto.

"Plante singulièrement étroite dans toutes ses parties, d'un tissu dur, bien différent du tissu diaphane de *T. pyxidiferum*.

"Hab. Costa-Rica inter muscos epiphyticum. I. Wercklé.

"Obs. Cette forme semble être assez répandue dans l'Amérique centrale. Je l'ai très bien caractérisée du Mexique. I. Pringle 3800 avec la désignation erronée: *T. radicans* Sw. Je l'ai du S. du Brésil. I. Schwacke."

As in many species of *Trichomanes*, the leaf-segments in this plant vary in width, sometimes becoming very contracted, giving the plant a still stiffer look. A curious line parallel with the margins, resembling a false vein broken at intervals, is to be seen in the dried leaves by transmitted light,* but disappears on soaking them in water.† It seems to be formed by some contraction of the leaf-tissue. A note evidently referring to this, on the labels of some of H. H. Smith's plants, reads "the streaks parallel with the veins are a constant character," so it may be they appear also in living plants.

Additional specimens of *Trichomanes pyxidiferum* are in the Underwood Herbarium, as follows:—

CUBA: "Cuba Orientale," *Wright 1807*, *906* in part, *907* in part.

JAMAICA: "Old England," below Cinchona, 1070 m. alt., *Underwood 1666*.

MEXICO: moist virgin forest, 1524 m. alt., *W. A. Murrill & Edna L. Murrill 35;* without locality, *Fred Müller 400*, *Sartorius*.

PERU: near Tarapoto, *R. Spruce 4761;* without locality, *Matthews*.

COLOMBIA: rather rare on trees, damp forest, Sierra del Libano, 1524–1828 m. alt., *H. H. Smith 2255;* on trees and rocks, damp

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* See PLATE 30, FIG. 5. A magnifying glass showed this also in the original photograph of FIG. 3.

† See PLATE 30, FIG. 6.

forest, Sierra de Onaca, 1070–1930 m. alt., *H. H. Smith 2443*, in part.

BOLIVIA: San Juan, 1161 m. alt., *R. S. Williams 1207*.

AFRICA: Perie-Wald, Capland, 600 m. alt., *O. Kuntze*.

The question now comes up, what is Hedwig's plant? The earliest name for this that I have been able to fix upon so far with any degree of certainty is *Trichomanes hymenophylloides*, the name given by Van den Bosch in 1863 to his *T. leptophyllum*,* which is a homonym of *T. leptophyllum* A. Cunningham. Van den Bosch's publication of his *T. leptophyllum* reads as follows: "*T. leptophyllum*. *T. pyxidiferum*. Hook. & Grev. tab. 206; Hook. sp. fil. 1, p. 121 (fide specim.)

"Hab. St. Vincent! Martinique! Guadeloupe! Jamaica! St. Domingo! Cuba!"†

Hooker and Greville's plate 206 and the long and careful accompanying description are based on specimens from St. Vincent, collected by the Rev. L. Guilding. These specimens I have not seen, but the plate and description agree well with a large series of specimens from St. Vincent and other parts of tropical America. These specimens in turn connect this plate with that of Hedwig's, which represents a less mature and more contracted leaf-state of the plant than Hooker and Greville's.

Both plates are reproduced in part on PLATE 31 of this paper, together with photographs of leaves of specimens from Santo Domingo and Jamaica.

It is scarcely necessary to reprint here Hooker & Greville's description. The essential points of it, the characteristics by which the plant differs from the plant I refer to true *T. pyxidiferum*, will be seen on PLATE 31. These are: the more slender almost delicate character of the leaf; the straighter more slender rachis; and, most conspicuously, the shape of the indusium. This, instead of being short and broad, has a long slender tube and a suddenly flaring mouth. The amount of leaf-tissue on either side of this indusium varies, even in the same leaf, as will be seen from FIG. 4. It is considerably greater in Hooker & Greville's figure than in Hedwig's, as might be expected from a figure representing, as has already been stated, a much more mature and luxuriant

* Ned. Kr. Arch. 5^3: 209. 1863.

† Ned. Kr. Arch. 4: 363. 1859.

form of the plant. Hooker and Greville, commenting upon the indusium in relation to Plumier's plant, with which they supposed theirs to correspond, write: "A remarkable character is described by Plumier in the fructification of this plant; for the fronds, he says, are 'garnies la pluspart, dans le fond de leur découpure, d'une petite boëte, ou calice, rempli de plusieurs vesicules, et scelé par un couvercle garni d'un petit poil dans le milieu.' Now that the involucres should be closed by a convex lid, through which the columella is continued, we consider to be a circumstance impossible in the genus: but we can very well believe that, to an eye unassisted by the microscope, the large expanded and entire (not two-lipped) mouth of the involucre may have the appearance of a lid. And this dilatation of the mouth of the involucre is more remarkable than in any other species of the genus we are acquainted with. We shall be happy if other botanists concur with us in this opinion, and thus determine with tolerable satisfaction the identity of a species, which no one seems to have understood since the time of Plumier." In this connection it may be stated that in dried specimens, at least, of the plant I refer to *T. pyxidiferum*, the indusium, while not strictly two-lipped, is at first bent inward at the apex in a falsely two-lipped fashion, the two edges pressed close together except where the "columella" pushes through, so that it resembles a saccate involucre closed by a sort of convex top, although, of course, this cannot be called a "lid" in any strict sense of the word. No "streaks" or "lines," similar to those I have described in leaves of *T. pyxidiferum*, occur in *T. hymenophylloides*.

Specimens of *T. hymenophylloides* are in the Underwood Herbarium, as follows:—

PORTO RICO: Maricao, *F. L. Stevens 1987;* El Gigante, *F. L. Stevens 1512;* on tree fern, Monte Cerrote, near Adjuntas, 900–1050 m. alt., *Britton & Brown 5426;* on tree fern, between Adjuntas and Jayuya, Arroyo de los Corchos, 800–900 m. alt., *Britton, Cowell & Brown 5267a;* creeping on tree trunks in forest, Rio Prieto and adjacent hills, Sierra de Naguabo, 910 m. alt., *J. A. Shafer 3622;* on dripping wet rocks, Rio Prieto and adjacent hills, 690–1,035 m. alt., *J. A. Shafer 3597;* on rocks in mountain forest, Alto de la Bandera, near Adjuntas, *Britton & Shafer 2070.*

HISPANIOLA: Province of Barahona, Santo Domingo, *Fuertes 1511*.

CUBA: slopes and summit of El Yunque, near Baracoa, 304–608 m. alt., *Pollard & Palmer 158a* in part.

JAMAICA: Morce's Gap, 1493 m. alt., *W. Harris Fl. Jam. 7114;* trail from Vinegar Hill to Mabess River, *Underwood 1253;* Mabess River, below Vinegar Hill, 912 m. alt., *Underwood 1260* in part, *1263;* near Cuna-Cuna Pass, 820 m. alt., *Underwood 2726;* Maybess River, *George L. Fisher 43;* Morce's Gap, *George L. Fisher 110;* vicinity of Morce's Gap, 1,500 m. alt., *W. R. Maxon 2764;* without locality, *Jenman, Wilson*.

GUADELOUPE: without locality, *Madiana;* various localities, *Duss 4436* in part, *4297, 4298*.

MARTINIQUE: Bois de la Calebasse, 360–810 m. alt., *Duss 4059;* Bois du Lorrain, 350–800 m. alt., *Duss 1627*.

DOMINICA: Mt. Diablotin, *F. E. Lloyd 864;* Laudat, *F. E. Lloyd 347, 147;* Hempstead, *F. E. Lloyd 649*.

ST. KITTS: on trees in forest, Belmont, *Britton & Cowell 401;* on trees in forest, Wingfield Estate, *Britton & Cowell 452*.

MONTSERRAT: Pond Mountain, near Rocbes, 610 m. alt., *Shafer 780;* Chaner's Mountain, 610 m. alt., *Shafer 776*.

GRENADA: without locality, *Jenman;* without locality, *Sherring;* Grand Etang, St. Georges, *W. E. Broadway*.

ST. VINCENT: forest, upper Richmond and Wallibon Valleys, on trees, 456–547 m. alt., *H. H. & G. W. Smith 1724;* without locality, *H. H. & G. W. Smith 61*.

TRINIDAD: without locality, *Jenman;* without locality, *Fendler 143, 145*.

MEXICO: moist virgin forest, 1524 m. alt., *W. A. & E. L. Murrill 38*.

GUATEMALA: Pensamalá, Depart. Alta Verapaz, 1161 m. alt., *H. v. Tuerckheim 949*.

COLOMBIA: damp forest, especially glens, near streams, common on trees, logs and rocks, Las Partidas, 1070 m. alt., *H. H. Smith 2256;* on rocks by stream, damp forest, Sierra del Libano, 1828 m. alt., *H. H. Smith 2442;* damp forest, common on trees, Sierra de Onaca, 760–1980 m. alt., *H. H. Smith 2443* in part.

ECUADOR: Andes, *R. Spruce 5355*.

NEW YORK BOTANICAL GARDEN

Description of plates 30 and 31

PLATE 30

TRICHOMANES PYXIDIFERUM L.

FIG. 1. Reproduction of part of *pl. 50*, Plumier's Traité des fougères de l'Amérique. Paris. 1705.

FIG. 2. Leaf from Santo Domingo, *H. v. Tuerckheim 3069*, natural size.

FIG. 3. Leaf from Costa Rica, *Wercklé*, natural size, authentic specimen of *T. junceum* Christ from Christ's herbarium.

FIG. 4. Leaf from Mexico, *Pringle 3800*, natural size, referred by Christ to *T. junceum*.

FIG. 5. Part of a dried sterile leaf from specimen shown in FIG. 2, enlarged.

FIG. 6, Part of a fertile leaf from specimen shown in FIG. 2, after soaking in water, enlarged.

PLATE 31

TRICHOMANES HYMENOPHYLLOIDES Van den Bosch

FIGS. 1, 3, 4. Reproduction of part of *pl. 206*, Hooker & Greville's Icones filicum. London. 1831. FIGS. 1, 3. Fertile leaves. FIG. 4. Portion of a fertile leaf, enlarged.

FIGS. 2 and *c*. Reproduction of part of *pl. 3*, Hedwig's Filicum genera et species. Leipzig. 1799.

FIG. 5. Leaf from Santo Domingo, *Fuertes 1511*, natural size.

FIG. 6. Leaf from Jamaica, *Underwood 1260*, natural size.

FIG. 7. Part of a fertile leaf from specimen shown in FIG. 5, enlarged.

Ruppia anomala sp. nov., an aberrant type of the Potamogetonaceae

C. H. Ostenfeld

(WITH PLATE 32)

Ruppia anomala sp. nov. Habitu fere ut *R. maritimae* subsp. *rostellatae*. Caulis filiformis, ramosissimus; folia filiformia; pedunculus post anthesin brevis nec elongatus, rectus; thecae antherarum subglobosae; pollinis cellulae semilunariter curvatae; carpidia 2–4, oblique ovoidea; stigma peltatum, supra visum subrotundum; carpella fructifera oblique ovoidea, apice breviter et oblique attenuata, a basi concreta divergentia; carpellorum podogyna in unum conjuncta; podogynum commune striis longitudinalibus conjunctionem demonstrantibus constructum, sursum incrassatum.

Praecipue differt ab omnibus *Ruppiis* carpellis fructiferis basi concretis, in apice podogyni communis positis.

Porto Rico: border of Lake Guanica, March 11 and 12, 1913, *N. L. Britton & J. A. Shafer 1870*.

In December, 1913, I visited the New York Botanical Garden and studied the collections of the so-called "sea-grasses." In the herbarium material I found a strange plant, habitually like a slender *Ruppia*, but with quite different fruits. I pointed out to Dr. N. L. Britton that this plant, which he had himself collected at the border of a lagoon, Lake Guanica, in Porto Rico, was an unknown plant, at least to me. He then asked me to examine it more closely and, if new, to describe it, and after my return from the West Indies I had the material sent to Copenhagen for study.

I thought at first that we had to do with a new genus, but now I consider it better to regard the plant in question as an aberrant species of *Ruppia*.

The morphology of the stem and leaves is the same as in an ordinary slender and tiny *Ruppia maritima* L.* Also the morphology of the *flower* is in all essential points as usual. Each of the two stamens consists of two anther halves (thecae)

* See, for example, Graves, A. H. The morphology of *Ruppia maritima*. Transact. Connecticut Acad. **14**: 59–170. *pl. 1–15*. 1908.

and a connective with an outgrowth of a conical shape; the thecae are round-ovoid with a slight furrow indicating their two sacs. The pollen grains are of the same bow-shaped form as in *R. maritima* and with the same delicate reticular thickenings of the outer surface (see Graves, *pl. 12*). The female part of the flower consists of two or four pistils of oblique-ovoid form and with a peltate sessile stigma. The ovule and the integuments do not show anything remarkable, and the finer study of the development of the megasporangium was not possible owing to the fact that the material available was all herbarium specimens.

The peculiarity of the plant does not show itself before we come to the fruit. The peduncle does not lengthen to any evident degree after the fertilization; it remains short as in the subsp. *rostellata* (Koch) Asch. & Graebn. of *R. maritima*. The main point of distinction between our new species and the others is the development of the stipe of the fruit. In *R. maritima* and other species each sessile pistil after fertilization grows out to a stipitate fruit, thus forming four free and distinct drupelets which are long-stalked in most species, but short-stalked in the var. *brevirostris* Agardh of *R. maritima*. In our new species the stipes of the drupelets are united into one common stipe (a podogynium), upon which four longitudinal furrows show the lines of concrescence. At the top of the podogynium the drupelets are placed in a star-like manner; their form does not show any essential difference from that of the drupelets in *R. maritima*. The length of the podogynium varies much, sometimes it is very short, not reaching that of the drupelet, sometimes it is nearly twice as long; but it does not reach such dimensions as the stipes of the free drupelets in *R. maritima*.

Very often only one or two pistils are fertilized, and we then find the abortive pistils as small warts at the top of the podogynium. The concrescence of the stipes goes on in spite of the abortion of some of the pistils; but the podogynium seems to remain shorter in the cases where only one drupelet has been developed.

I have had plenty material at hand, and the development of the fruit has been the same in all specimens seen. Otherwise I would have considered it as a teratological abnormity; now I must regard it as the normal state of this plant. It places the species

in a very remote place in the genus, and even in the whole family of *Potomogetonaceae*, of which one of the main characters is the distinct and free carpels.

As I have not collected the plant myself, I do not know if the conditions of life are in any regard peculiar; it may be that a closer study of the plant in its natural environment will elucidate the mystery which always seems to lie behind such a case where a plant being like a common species in most respects differs in one essential point. This new species of *Ruppia* has an analogue in the famous *Capsella Heegeri* Solms,* which only differs from the common *Capsella Bursa-pastoris* L. in the shape of the fruit, a character which would remove it from the genus *Capsella* and from the group of genera to which *Capsella* belongs, if purely formal reasoning was used.

It is possible that *Ruppia anomala* has sprung from *R. maritima* in a similar manner to that supposed to have been the case when *Capsella Heegeri* was found on the drill-ground at Landau in Germany. It is to be hoped that some botanist will be able to visit Lake Guanica and study the *Ruppia* in a more thorough manner than I have been able to do. Perhaps he will clear up the matter; at present we have only to consider it a new and aberrant species.

NOTES

After the manuscript of this article was sent to America for publication, Dr. N. L. Britton informed me that he had visited Lake Guanica again this year and had collected a *Ruppia* which he was sending me for examination. When this material arrived it was at once evident that we had to do with the widespread *Ruppia maritima*. The specimens were in flower and fruit and showed elongated, partly coiled peduncles and *free* and long-stipitate drupelets, i.e., they were quite typical *R. maritima*, none exhibiting the peculiar characteristics of the plant described above. As to the collecting place Dr. Britton said, "the *Ruppia* came from the same shore of Lake Guanica that the other aquatic plant was obtained from. I cannot say that it was at exactly the same spot, but it must have been within one or two hundred meters." This is a very interesting

* Solms-Laubach, H. Graf zu. Cruciferenstudien I. *Capsella Heegeri* Solms, eine enu entstandene Form der deutschen Flora. Bot. Zeit. **28**: 167. 1900.

observation, and it makes the present case still more parallel to that of the finding of *Capsella Heegeri*. The new form has evidently sprung from the true *R. maritima* at the spot. I will repeat the wish expressed above as to a thorough study of the plant *in situ* and only regret that an experimental study of a plant of this kind would involve considerable difficulty.

In a paper on the postglacial plant-remnants of the moors of Norway, Jens Holmboe* has mentioned (p. 149) and figured (*pl. 2, f. 19*) an anomalous fruit of *R. maritima* in which the two fruitlets were united at their base and supported by one very long common podogynium, thus a case much resembling the fruits of the new Porto Rican species. He says that he found only one fruit of that kind amongst several thousand normal fruits. I owe this reference to Mr. Knud Jessen of Copenhagen.

BOTANISK MUSEUM, COPENHAGEN.

Explanation of plate 32

RUPPIA ANOMALA Ostenfeld

FIG. 1. Part of a plant showing the fruiting stalk. The upper fruit has three well-developed drupelets and a long podogynium, the lower only one well-developed drupelet and a short podogynium. × 2.

FIG. 2. Spike before flowering, showing 2 stamens and 2 pistils in each flower bud (microscope system, Winkel, Ob. 4, Oc. 1).

FIG. 3. Another flower bud from the side (Ob. 4, Oc. 1).

FIG. 4. A pistil showing the position of the egg and its integuments (Ob. 3, Oc. 1).

FIG. 5. A flower after flowering; none of the pistils has been fertilized and no growth has taken place (Ob. 1, Oc. 1).

FIG. 6. A fruit of which one drupelet has developed, the three remaining unfertilized appearing as warts (Ob. 1, Oc. 1).

FIG. 7. Pollen grains (Ob. 6, Oc. 1).

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*Planterester i Norske torvmyrer. Kgl. Norske Vidensk. Selsk. Skr. I. No. 2. 1903.

On the distribution and correlation of the sexes (staminate and pistillate flowers) in the inflorescence of the aroids Arisarum vulgare and Arisarum proboscideum

J. Arthur Harris

(with two text figures)

I. Introductory Remarks

Because of its high degree of specialization the inflorescence of the aroids should present most interesting, and in some instances favorable, material for biometric studies.

So far as I am aware, however, practically nothing is known in quantitative terms of variation and correlation in the inflorescence of this group. In this note I present the results of an analysis of the data for two species collected by Cannarella. I hope that the publication of these results will suggest to those who have the opportunity, the desirability of obtaining more adequate series of quantitative data on this group. The structural peculiarities of the Aroids are too well known to botanists to require comment. Those who wish further details for *Arisarum* may consult the well-known monographs by Engler. The two species here considered are figured in Curtis's Botanical Magazine, *pl. 6023, 6634.*

In the case of *Arisarum vulgare* Cannarella* has given data for number of male and female flowers in the inflorescence. These he tables in several different ways, but without bringing out the full significance of the observations. For *Arisarum proboscideum*† he has recorded the data for number of staminate and pistillate flowers per inflorescence for a series of individual habitats. Beyond a descriptive discussion he gives no analyses of these data except to state that the correlation between the number of male and female flowers for the total material is $r = -.069$. A negative value in a character such as the present leads one to suspect arith-

* Cannarella, P. Ricerche intorno di limite di variabilitá dell' *Arisarum vulgare* Torg. Nuovo Gior. Bot. Ital. N. S. **12**: 328–347. 1905.

† Cannarella, P. Ricerche sull' apparato florale dell' *Arisarum proboscideum* Savi. Cont. Biol. Veg. R. Ist. Bot. Palermo **4**: 121–138. 1909.

metical error. As will be shown presently the correlation is not negative but positive in sign, though numerically small. For all details concerning habitats and other biological conditions the original papers must be consulted.

II. STATISTICAL ANALYSIS OF DATA

Consider first the means and variabilities of the number of staminate and pistillate flowers in the inflorescences of the two species. For this discussion only the total materials collected for each species will be used. In *A. vulgare* the range of variation in number of staminate flowers is very great. The classes and the frequency with which they occur, together with the total number of pistillate flowers found on the inflorescences, are shown in TABLE I.

TABLE I

FREQUENCY OF STAMINATE FLOWERS AND ASSOCIATED PISTILLATE FLOWERS IN *A. vulgare*

Staminate flowers	*f*	Total pistillate flowers	Staminate flowers	*f*	Total pistillate flowers
8	1	3	35	41	209
14	1	6	36	37	202
16	1	13	37	37	254
17	1	1	38	30	189
18	3	12	39	39	263
19	2	15	40	21	140
20	1	4	41	26	175
21	4	13	42	21	147
22	3	14	43	11	74
23	8	37	44	14	108
24	13	53	45	6	50
25	9	50	46	5	38
26	23	119	47	2	14
27	14	64	48	4	39
28	16	80	49	3	31
29	31	132	50	2	19
30	33	155	51	1	5
31	30	156	53	1	6
32	37	186	57	3	42
33	33	164	59	1	7
34	50	269	Totals.....	619	3,558

The variation in the number of pistillate flowers may be calculated from the totals of TABLE II. The data for *A. proboscideum* appear in the totals of TABLE III. From these I deduce the constants for number of flowers per inflorescence given in TABLE IV.

The fact that the two species differ greatly in the numbers of the two types of flowers which they produce is well known to taxon-

omists. Any discussion of the differences in the means of the two species would therefore be superfluous. Since the mean numbers are all conspicuously lower in *A. proboscideum* one would naturally expect the absolute variabilities as measured by the standard deviations to be lower also. The constants show that this is actually the case. The coefficients of variation show that *A. proboscideum* is also *relatively* far less variable than *A. vulgare*. The result is rather surprising in view of the fact that the collections of *A. proboscideum* were apparently made from a wider range of habitats than those for *A. vulgare*.

The coefficients of variation for number of pistillate flowers are in both species conspicuously higher than those for staminate flowers. The interpretation of this result presents considerable difficulty. Variation in both cases is so low that a deviation of a unit is relatively far greater than in the case of the staminate flowers. Thus without a full consideration of the statistical difficulties presented by the case one cannot assert that biologically there is a greater tendency to variability in the number of pistillate than in the number of staminate flowers.

TABLE II

CORRELATION IN INFLORESCENCES OF *A. vulgare*

PISTILLATE FLOWERS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Totals
Staminate flowers:																	
6–10	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1
11–15	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	1
16–20	1	—	—	4	1	—	—	—	—	1	—	—	1	—	—	—	8
21–25	1	1	13	10	—	5	1	6	—	—	—	—	—	—	—	—	37
26–30	—	2	22	42	23	13	6	7	—	1	1	—	—	—	—	—	117
31–35	—	2	31	54	29	33	18	20	2	—	—	2	—	—	—	—	191
36–40	—	—	7	26	22	35	28	30	7	3	—	4	2	—	—	—	164
41–45	—	—	5	7	9	11	12	17	6	4	1	3	3	—	—	—	78
46–50	—	—	—	—	1	3	2	1	3	1	4	—	—	—	1	—	16
51–55	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	2
56–60	—	—	—	—	—	—	1	—	—	—	—	1	—	1	—	1	4
Totals.....	2	5	79	143	86	102	68	81	18	10	6	10	6	1	1	1	619

The correlation surfaces for the two species are given as TABLES II and III. That for *A. proboscideum* appears in units. For *A. vulgare* the range of variation in number of staminate flowers is so wide that it has seemed desirable to group in classes

of 5 units range. The correlation coefficient for the ungrouped material may be computed from the condensed correlation TABLE I. The correlation constants in TABLE IV are calculated from the ungrouped observations. The first point to be noted is that the less variable inflorescence of *A. proboscideum* shows a distinctly lower correlation between the number of staminate and pistillate flowers than does that of *A. vulgare*. The difference is .226 ± .025, a value 9 times as large as its probable error and so unquestionably significant.

TABLE III

CORRELATION IN INFLORESCENCE OF *A. proboscideum*

	PISTILLATE FLOWERS						
	1	2	3	4	5	6	Totals
Staminate flowers:							
10	—	1	—	—	—	—	1
11	1	—	1	—	—	—	2
12	3	10	—	—	—	—	13
13	5	38	7	—	—	1	51
14	10	105	19	2	2	—	138
15	8	144	81	18	15	—	266
16	8	195	186	55	16	—	460
17	13	304	416	34	14	—	781
18	8	302	218	26	12	—	566
19	3	76	106	29	25	2	241
20	—	49	58	26	20	—	153
21	—	20	36	12	7	—	75
22	—	6	31	6	1	—	44
23	—	6	3	—	1	—	10
24	—	—	1	—	—	—	1
Totals.....	59	1,256	1,163	208	113	3	2,802

If one expresses the results in terms of regression the linear equations are

For *A. vulgare:*

$$p = .3796 + .1560\, s,$$

$$s = 27.205 + 1.252\, p.$$

For *A. proboscideum:*

$$p = 1.0299 + .0955\, s,$$

$$s = 15.836 + .490\, p,$$

where s = number of staminate and p = number of pistillate flowers.

These values are deduced from the ungrouped observations.

For *A. vulgare* it seems desirable to calculate regression on the grouped values given in TABLE II. This gives for the correlation

$$r_{sp} = .440 \pm .022,$$

a value differing from that obtained from the ungrouped observations by only about one tenth its probable error. The regression equations are

$$s = 27.065 + 1.274\, p,$$

$$p = .5280 + .1518\, s.$$

These are the lines in the diagram, FIG. 1.

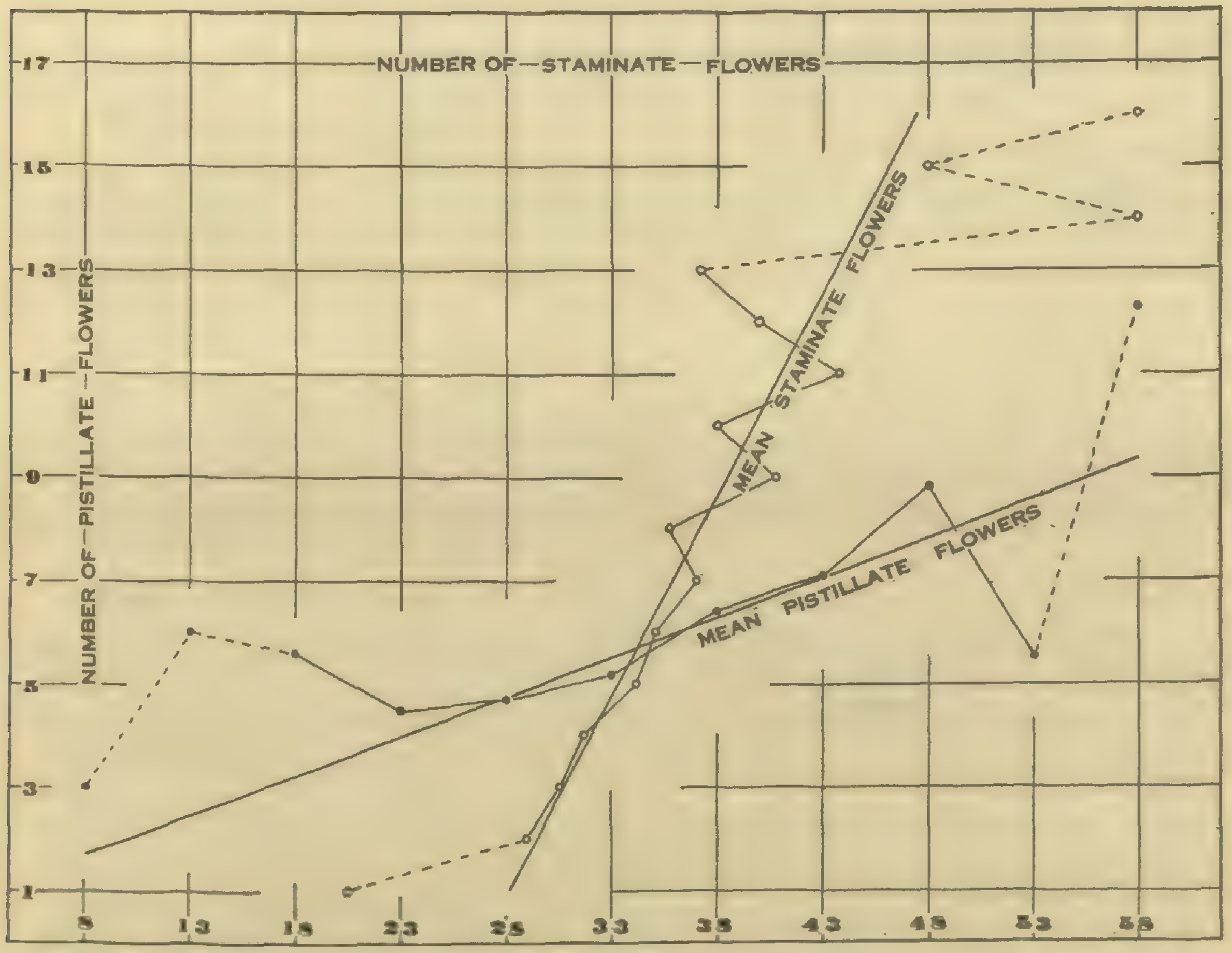

FIG. 1. Relationship between number of pistillate and number of staminate flowers in the inflorescence of *Arisarum vulgare*.—Empirical means and calculated lines.

These diagrams show considerable irregularities in the distribution of the means of the numbers of pistillate flowers associated with different numbers of staminate flowers and *vice versa*. It seems desirable, therefore, to apply a statistical test of the goodness of fit of the straight lines to the empirical means. Calculating

the correlation ratio* and using Blakeman's† well-known criterion

$$\frac{\zeta}{E\zeta} = \frac{\sqrt{N}}{.67449}, \quad \frac{1}{2}\sqrt{\zeta} \cdot \frac{1}{\sqrt{1 + (1 - \eta^2)^2 - (1 - r^2)^2}}.$$

I find:

	A. vulgare	*A. proboscideum*
Correlation coefficient	.440 ± .022	.216 ± .012
Correlation ratios:		
From means of pistillate flowers	.495 ± .020	.290 ± .012
Blakeman's criterion	4.38	7.87
From means of staminate flowers	.486 ± .021	.233 ± .012
Blakeman's criterion	3.96	3.37

TABLE IV

STATISTICAL CONSTANTS FOR *Arisarum*

	For *A. vulgare*	For *A. proboscideum*
Number of staminate flowers:		
Mean	34.402 ± .175	17.143 ± .024
S.D.	6.463 ± .124	1.850 ± .017
C.V.	18.79 ± 0.37	10.79 ± 0.10
Number of pistillate flowers:		
Mean	5.748 ± .062	2.668 ± .010
S.D.	2.282 ± .044	0.817 ± .007
C.V.	39.70 ± 0.87	30.62 ± 0.30
Total flowers per inflorescence:		
Mean	40.150 ± .210	19.810 ± .028
S.D.	7.747 ± .149	2.178 ± .020
C.V.	19.29 ± 0.38	10.99 ± 0.10
Correlation of staminate and pistillate flowers	.442 ± .022	.216 ± .012

The values of Blakeman's criterion all suggest significant non-linearity. The one which may be given the greatest weight is that for the regression of pistillate or staminate flowers in *A. proboscideum*. An examination of the diagram, FIG. 2, shows a peculiar and (on the basis of the data in hand) quite inexplicable periodicity in the distribution of the mean number of pistillate flowers. While the graphs themselves and the critical statistical constants indicate that straight lines do not exactly describe the interrelationship between the two variables, it is impossible to assert from the data as they stand that any curve of a higher order would express the rate of change in the mean value of an associated character

* Pearson, K. Drapers' Co. Res. Mem., Biom. Ser. II. 1905.

† Blakeman, J. Biometrika 4: 332–350. 1905.

better than is done by a straight line. Such deviations as do occur are probably due for the most part to the unavoidable errors of sampling. At any rate, the discussion of this point cannot be carried farther without more adequate biological information.

It is interesting to examine the results obtained for each of the sub-habitats from which *A. proboscideum* was collected.* These are the data combined to form our TABLE III.

The results for correlation between number of staminate and pistillate flowers, r_{sp}, are given in the third column of Table V. With but two exceptions the correlations are positive in sign. These two exceptional cases show very substantial negative coef-

TABLE V

CONSTANTS FOR INDIVIDUAL CORRELATIONS OF *A. proboscideum*

Locality	Number of plants	r_{sp}	r_{sp}/E_r	r_{ts}	r_{tz}	r_{tz}/E_r
Ospedallette.....	341	+.331±.033	10.19	+.922	−.413±.030	13.68
Picarelli.....	490	+.245±.029	8.55	+.876	−.482±.023	20.59
Scierta.....	465	+.090±.031	2.89	+.951	+.005±.031	.16
Zigarelli.....	48	+.290±.089	3.25	+.944	−.291±.089	3.26
Contrada.....	80	+.276±.070	3.96	+.981	+.123±.074	1.65
Ajello.....	13	−.422±.154	2.74	+.952	+.399±.157	2.53
Faliari.....	500	+.187±.029	6.42	+.927	−.209±.029	7.26
Lareto.....	685	+.106±.026	4.17	+.915	−.181±.025	7.27
Liquerini.....	16	−.566±.115	4.94	+.588	−.206±.161	1.28
Montefredani.....	164	+.077±.052	1.47	+.921	−.124±.052	2.38

ficients, which are apparently significant in comparison with their probable errors. Since the number of individuals is so small—only 13 and 16—the conventional method of computing the probable error can not be given too much weight. The two exceptions to the rule cannot, therefore, be regarded as a real argument against the general existence of a positive correlation. The average value of these correlations, obtained by weighting with the numbers of individuals upon which the several coefficients are based, is $\bar{r} = +.170$. The difference between this value and the $r = +.216$ obtained from the whole (massed) material gives some idea of the influence of heterogeneity on the magnitude of the correlation.

Consider now the relationship between the total number of flowers produced per inflorescence and the relative numbers of the

* The numbers are in some cases far too small to give trustworthy constants, but it has seemed best to calculate the results for all alike to avoid the possible criticism of selection of data.

two types of flowers in the inflorescence. This seems a question of considerable interest because of the many discussions of the influence of feeding or degree of development on sex.

The problem is approached statistically as follows. Let z

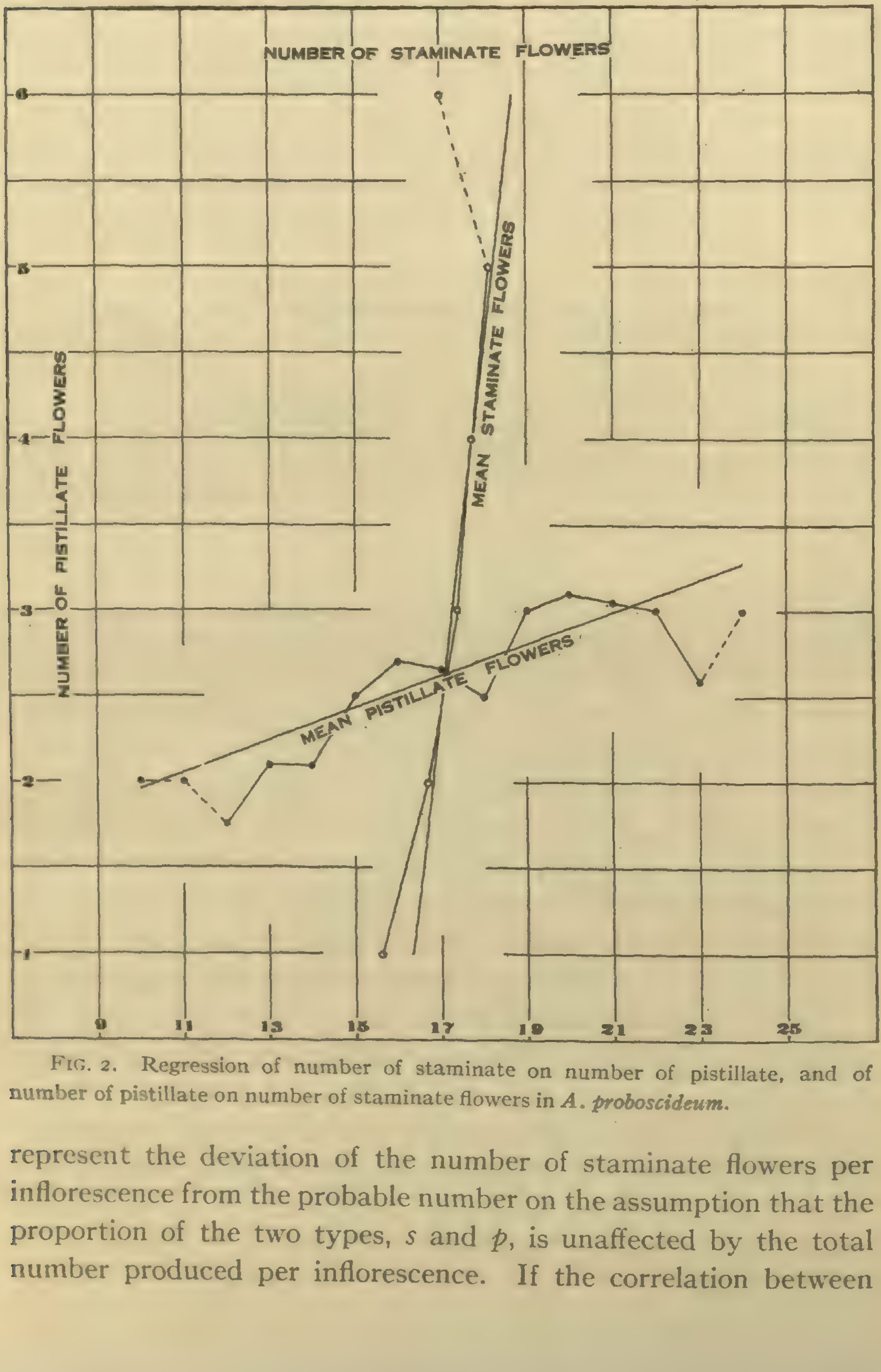

FIG. 2. Regression of number of staminate on number of pistillate, and of number of pistillate on number of staminate flowers in *A. proboscideum*.

represent the deviation of the number of staminate flowers per inflorescence from the probable number on the assumption that the proportion of the two types, s and p, is unaffected by the total number produced per inflorescence. If the correlation between

t, $= s + p$, or total flowers per inflorescence, and z be positive it indicates that as the total number of flowers per inflorescence becomes larger the staminate flowers are relatively more numerous. Using the formula suggested to me* by Professor Karl Pearson I find:

For *A. vulgare*:†

$$r_{tm} = + .964 \pm .002,$$

$$r_{tz} = - .230 \pm .026.$$

For *A. proboscideum*:

$$r_{tm} = + .931 \pm .002,$$

$$r_{tz} = - .234 \pm .012.$$

In both cases the correlation between total flowers and number of staminate flowers is high. This is as one would expect it to be. The interesting feature of the result is that in both species there is a significant *negative* correlation between the total number of flowers and the deviation of the number of staminate flowers from their probable value. In short, the male flowers while absolutely more abundant in the larger inflorescences are there *relatively* distinctly less abundant. Or in other words the larger inflorescences tend to produce a larger proportion of pistillate flowers.

Consider these relationships on the basis of the individual collections.

TABLE V, in which the constants for the individual collections of *A. proboscideum* are given, shows that with a single exception, in which N is very small, the correlations for total flowers and staminate flowers are very high.

The critical values derived from these are given in the sixth column. Of these 10 coefficients, 7 are negative in sign, and 5 may be considered unquestionably significant in comparison with their probable errors. Neither of the 3 positive values may be looked upon as certainly trustworthy. Thus while the constants for the individual sub-series are very irregular in magnitude they fully substantiate the conclusions to be drawn from the constant

* Harris, J. Arthur. The Correlation between a Variable and the Deviation of a Dependent Variable from its Probable Value. Biometrika 6: 438–443. 1909.

† Calculations from ungrouped data.

for the whole material. The average (weighted) value is $\bar{r}_{tz} = -.223$. This value is not significantly different from the $r_{tz} = -.234$ obtained from the combined materials.

III. SUMMARY AND CONCLUSIONS

As a suggestion for more adequate investigation of variation and correlation in the specialized inflorescence of the aroids this note presents the results of a statistical analysis of two rather large series of data collected for the genus *Arisarum* by Cannarella.

The following points may be emphasized:

In both *A. vulgare* and *A. proboscideum*, the coefficient of variation for number of pistillate flowers is far higher than that for number of staminate flowers. The interpretation of this result presents considerable difficulty.

In *A. vulgare* the inflorescence not only produces a larger number of both staminate and pistillate flowers than does that of *A. proboscideum*, but shows a far higher variability, both absolute and relative.

Apparently the collections of *A. proboscideum* came from a wider range of habitats than those of *A. vulgare*. If this be true, the variability which they show is in part due to heterogeneity arising through environmental differentiation. This probability renders more significant the observed lower variability in *A. proboscideum*. Any subsequent investigation should if possible take into account this factor in drawing comparisons between the variability of these or any other forms.

The inflorescence of *A. vulgare* is not only more variable, but shows a higher degree of correlation of its parts than does that of *A. proboscideum*. In both cases the correlation between number of staminate and pistillate flowers is rather small. The relationship between the numbers of the two types of flowers may be fairly well described by a straight line. The fit of the straight line equations is not altogether satisfactory, but it seems idle to carry the statistical analysis farther on the present data. The effort would much better be expended in securing more adequate biological material.

The correlation between the total number of flowers produced by the inflorescence and the number of staminate flowers is neces-

sarily positive and high. The correlation between the total number of flowers and the deviation of the staminate flowers from their probable value, on the assumption that the character (sex) of the flowers is independent of the size of the inflorescence, is significantly negative. This shows that the larger inflorescences have relatively more pistillate flowers.

COLD SPRING HARBOR,
NEW YORK

Dictyophlois reticulata gen. et sp. nov.

AUG. F. FOERSTE

(WITH PLATE 33)

The name *Stigmaria ficoides* Brongniart at present does service in designating the so-called roots of both of the genera of stems known as *Lepidodendron* and *Sigillaria*. Not only have these roots been found in direct connection with the *Lepidodendron* and *Sigillaria* stems but it has been found impossible so far to discover any specific or generic differences in the roots so connected.

The genus *Lepidodendron* makes its appearance in the Lower Devonian and dies out in the Permian. Recently Dr. David White has called my attention to the fact that in Mississippian or Subcarboniferous specimens of *Stigmaria ficoides* the characteristic round scars, indicating the points of attachment of the so-called rootlets, are distinctly smaller than in Pennsylvanian or Coal Measure representatives passing under the same name.

Students of the microscopic structure of *Stigmaria* and of its rootlet-like appendages, regard the latter as homologous with the monarch roots of certain living plants, so that the main axes of the so-called roots known as *Stigmaria* should be known as rhizophores rather than roots. There is a possibility that these rhizophores represent underground stems, but this still is a debatable question.

In the vicinity of Sample, two miles east of Stephensport, Breckenridge County, western Kentucky, the rhizophores of both *Stigmaria ficoides* and of an undescribed but related genus occur in one of the sandstone layers belonging to the lower part of the Chester division of Subcarboniferous rocks.

The undescribed rhizophores resemble those of *Stigmaria ficoides* in possessing small ring-like areas of attachment of the monarch roots, the latter being arranged in diagonally intersecting rows. In several of these ring-like areas a minute central point could be recognized, but the smaller ring, which in *Stigmaria* intervenes

between this central point and the larger ring, could not be identified with certainty in any case.

These undescribed rhizophores differ from those of *Stigmaria* in having the areas between the ring-like scars of attachment of the monarch roots marked by irregular ridge-like elevations and depressions presenting the appearance of an irregular network. In the immediate vicinity of the ring-like scars the ridge-like elevations of this network tend to be arranged in radiating series. The network evidently is a characteristic of the outer cortex, hence the name *Dictyophlois reticulata*, here proposed for the rhizophores in question. No explanation based on evidence can be assigned at present for the reticulate appearance of the surface of this outer cortex. But, if these rhizophores are homologous with subterranean stems rather than with roots, the reticulate structure may be connected with the former presence of more or less appressed scales, of which, however, there is no positive evidence in *Dictyophlois;* in *Stigmaria* the former presence of appressed scales seems impossible since the outer cortex of the rhizophores in the latter genus is smooth.

The specimens of *Dictyophlois* here described and figured were discovered about ten years ago and were retained in the hope that further evidence regarding their structure might be obtained. Since this delay has not been attended by any additional information the accompanying illustration is published in the hopes that it may arouse interest in other paleobotanists. If *Dictyophlois* is indeed an underground scale-bearing stem then these scales should be found sooner or later still attached to the rhizophores.

Dictyophlois reticulata gen. et sp. nov.

Original diameter of rhizophores varying from 10 cm. to 15 cm. The figured specimen (type) is a flattened fragment 10 cm. in length and 13 cm. in width, exposing a part of one side of a rhizophore, the original diameter of which is unknown. Round areas of attachment of the so-called rootlets usually 3.5–4 mm. in width, but not infrequently attaining a length of 5 mm.; with a small central pit about 0.75 mm. in diameter. These areas are arranged in diagonally intersecting series, five areas occupying a length of 60–80 mm. measured along the diagonal rows. For a distance of 3–4 mm. from the margins of these round areas of attachment the raised ridges forming the intermediate

network tend to be arranged in a more or less radiating manner. In the more distant parts of the intermediate area these ridges form a more irregularly reticulated network. Measured along the crests of the ridges, the meshes of the network frequently attain a length of 3 mm. and a width of 2 mm.; the included space frequently attains a depth of 1–1.5 mm., narrowing toward the bottom, so as to form an irregular funnel-like pit.

Type specimen in the possession of the writer.

KENTUCKY: Sample, Breckenridge County.

DAYTON, OHIO

Explanation of plate 33

DICTYOPHLOIS RETICULATA Foerste

Type specimen, collected at Sample, Breckenridge County, Kentucky. Natural size.

INDEX TO AMERICAN BOTANICAL LITERATURE

1915

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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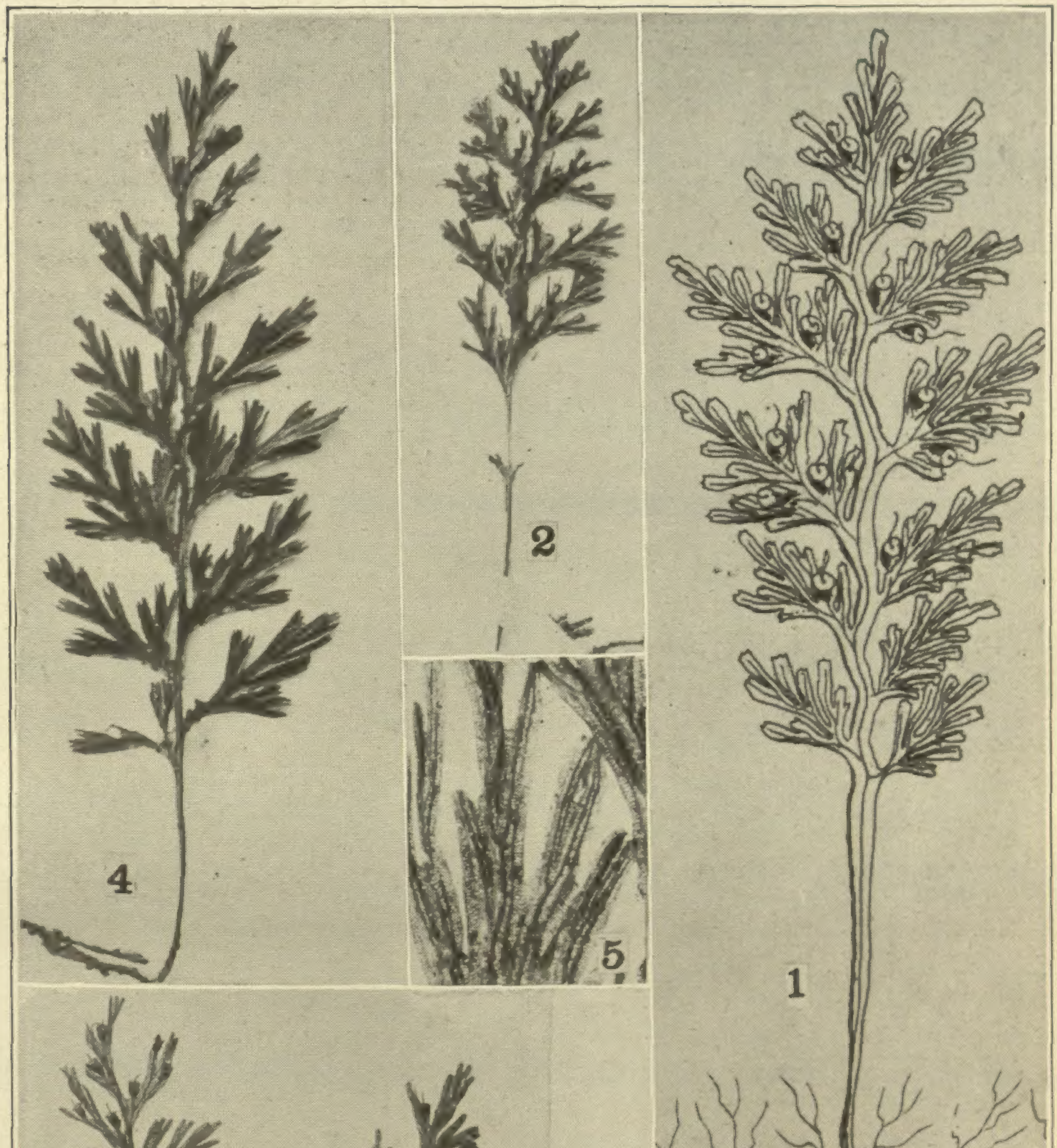
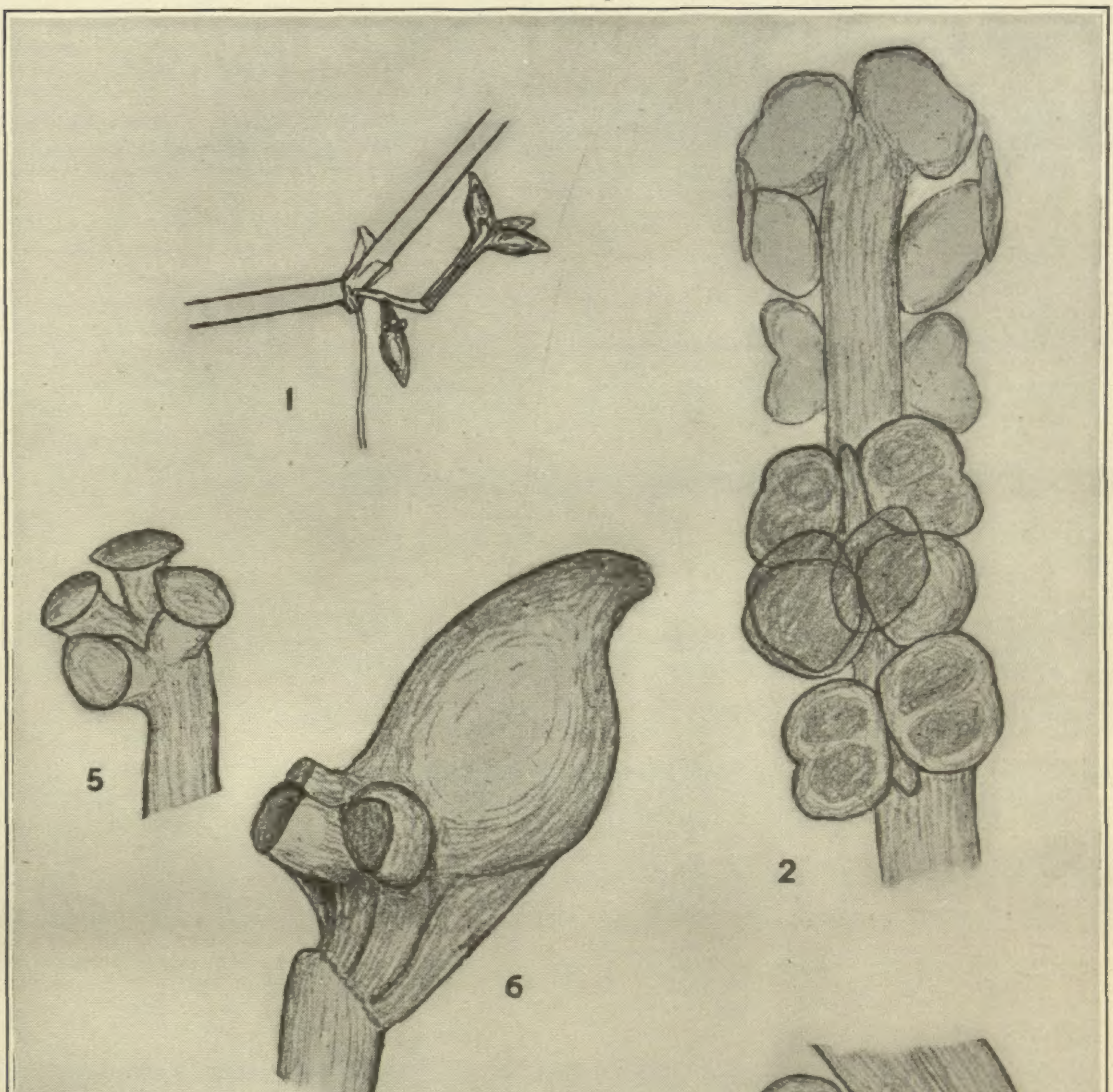


TRICHOMANES PYXIDIFERUM L.

TRICHOMANES HYMENOPHYLLOIDES VAN DEN BOSCH



RUPPIA ANOMALA OSTENFELD

DICTYOPHLOIS RETICULATA FOERSTE